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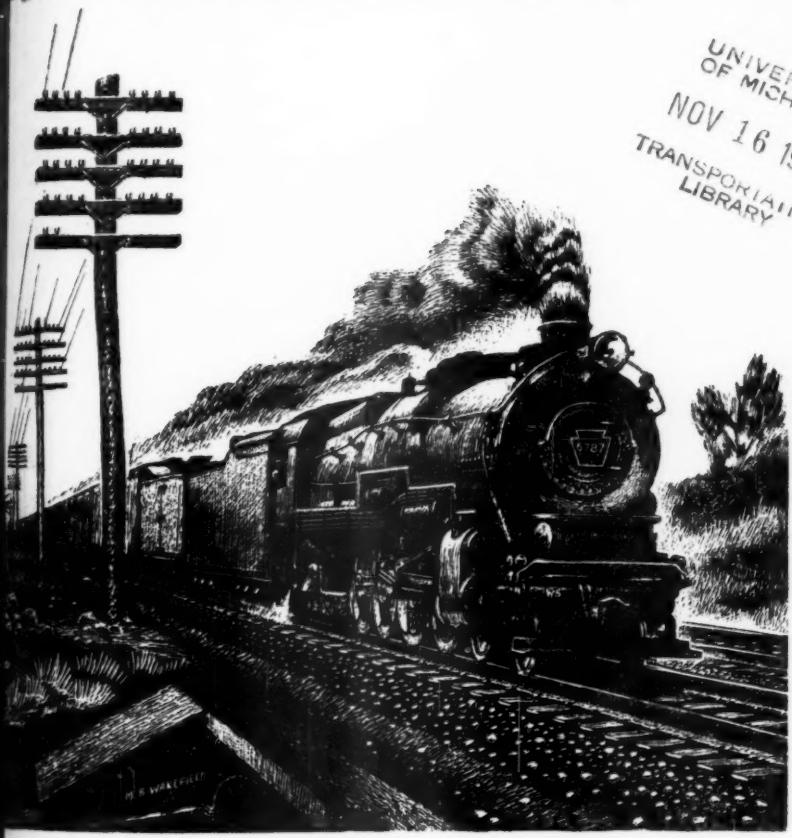

THE RAILWAY AND LOCOMOTIVE HISTORICAL SOCIETY

OCTOBER, 1954

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In presenting our last publication for the year we are calling attention to the contribution of Mr. Heydinger on "The English Influence on American Railroads." I think the majority of our members appreciate the influence that England, birthplace of the railroad, played in our own early railways. It has remained for the author to collect and arrange many of these facts, well-known to some of us, and place them in such form that they may be easily referred to. His chapter on financing of our early lines brings home the fact that without this overseas capital, many of our railroads would either have failed or else never been built.

Railroad history is made up of the builders and the operators of our railroads in addition to the equipment and we welcome the paper presented by Mr. Riffle on "The Magnolia Cut-Off." Once the rails are laid and the trains commence operation, it would seem as tho' most of the effort would be towards maintenance. Many times the original route had to be selected because of lack of capital and, as the years pass, new routes of easier grades and elimination of curvature need be built because of competition. A railroad is never completely finished and woe betides any management that feels that way. The building of the Magnolia Cut-Off was a huge undertaking and, traffic had to be moved during the work. Mr. Riffle has told of this work in a simple fashion and we believe it will interest many of our members.

Mr. Fullerton has contributed some of his boyish recollections of the Lima, Ohio station; Mr. Collom has sent a paper on the narrow

gauge railroads in the Pennsylvania oil fields; "Dave" Joslyn has added some interesting notes on the suburban locomotives developed by Mr. A. J. Stevens and lastly, Stewart Graham has contributed some notes that may set us to thinking about the first true mogul type locomotive.

We are including another of the Newton papers and we are bringing to a close the continued articles on Valve Gears by Fred Jukes and the locomotives of the Pennsylvania R. R. by your editor. The cover design was submitted by Manville B. Wakefield and shows one of the Class M-1a on the "head-end" of a freight train. We hope that you will find all of these contributions of interest.

The English Influence On American Railroads*

By Earl J. Heydinger

The debt the United States owes to England for our railroad system is far greater than either the average American or Englishman realizes; greater than historians of either nation effectively state. Most Americans at first would deny any obligation to England for the transportation benefits we enjoy today. Under pressure they might admit that the locomotive did develop in England and that a few came to this country over a century ago. A biased enthusiast might retort that English inventor Trevethick stole the locomotive from American Oliver Evans before 1800; the locomotive is an American invention.

This paper proposes to trace English transportation ideas across the Atlantic, and American reaction to these ideas: to follow the surprising number of Americans, who visited England, especially to observe the railroad and the locomotive, and the far-reaching results of these observations; to show the American adaptation of and improvement on the English locomotive; to enumerate some of the many publications and republications of English-inspired books and pamphlets, which preceded and followed the introduction of the railroad into the United States; to relate an example of construction by English engineers with English capital, equipment, rails and labor in America during the Civil War; and, finally, to relate a small part of the economic and political story of British financial aid, which accompanied the English locomotive and, especially the rail, to the United States.

Contrary to popular opinion, the dissemination of information on steam and rail transportation within the United States antedates the great triumphs of George Stephenson, antedates both the 1825 Stockton and Darlington opening and the 1829 Rainhill Locomotive Trials on the Liverpool and Manchester Railroad. English newspapers, magazines and books exported the latest facts to the English-speaking world. Visitors to England carried the ideas home. English commercial houses informed inquiring American customers. American engineers went to England for training, or were sent by organizations to learn the latest practice. Early nineteenth century communications may have been slow and unsure, but the ideas crossed the ocean despite obstacles.

Had George Stephenson carried out either his 1808 or 1819 deliberations about emigration to the United States, America might have been the scene of Stephenson's locomotive successes rather than England.

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*As an original paper, prepared by the author while at Lehigh University, Bethlehem, Pa., this article was thoroughly documented, and its footnotes gave many pertinent sidelights to the text. Due to space limitations of the bulletin, it was necessary to omit the documentation and footnotes. A comprehensive bibliography which accompanied the article, is included, in the belief that it will be of infinite value to anyone wishing to delve further into this unusual phase of American Railroad history.

His son, Robert Stephenson, in returning to England from South America, made a short tour of the United States and Canada in 1827, but left little record of where he visited, other than Niagara Falls, or of his impressions of the United States and its transportation problems.

I. EARLY ENGLISH INFLUENCE

Benjamin Henry Latrobe (1764-1820) studied and worked with the famous English engineer, Smeaton. In answering Gallatin's request for information on canals and turnpikes, he volunteered information on railroads. First, a railroad might be used as an adjunct to canals, "a last resort," an expensive, inconvenient and imperfect means of crossing high areas where water is scarce. Then, in a critical analysis of the canals already built along the Susquehanna, Potomac and James Rivers, he suggested that railroads could make the coal from the James River Field more available to tidewater, especially by a line from Ampthill up Fall's Creek.

In a postscript, Latrobe added a "few remarks on railroads . . . [because] public attention has been often called to this sort of improvement, and the public mind filled with very imperfect conceptions of its utility." Telling that either timber or iron rails might be used for construction and that cast iron laid on stone was more durable, he advised that cast iron rails on beds of timber were both durable and within the ability of this country to finance. The gauge recommended varies from 3½ to five feet; rails are described at ⅝" thick and L-shaped (wheels unflanged) laid on timber rails. Cost per mile of double track is estimated at $10,000, with the iron being nearly three-fourths of the cost, $7,240. Capacity with a single horse is rated at eight tons in four wagons.

The astonishing loads drawn by a single horse on English railroads, Latrobe told, had raised hopes that railroads would soon be built in the United States. Their utility, he repeated, would be confined to the James River Coal Fields, or from the marble quarries near Philadelphia, to the Schuylkill River. Finally, railroads as a means of overcoming difficult parts or artificial navigation are termed "invaluable and in many instances offer the means of accomplishing distant lines of communication which might remain impractical even to our means for centuries to come."

Printed in two 1808 editions, this report was reprinted twice in 1811, and four times in the next eleven years. Latrobe's sons, John Hazelhurst and Benjamin H., and his pupils, Robert Mills, of South Carolina, and William Strickland, of Philadelphia, built and planned America's earliest railroads. Latrobe, however, hadn't recognized the value of Oliver Evans' 1786 high-pressure steam carriage, a predecessor of the locomotive. He reported to Philadelphia's American Philosophical Society that it was impractical.

Colonel John Stevens (1750-1838) took Latrobe's railroad recommendations, added information from the English magazine, *A Journal of Natural Philosophy, Chemistry and the arts,* edited by W. Nicholson

and advocated that New York build a three-hundred-mile railroad, rather than a canal, from Albany to Buffalo. Predicting speeds of a hundred miles per hour to be possible, but holding that twenty to thirty miles would be the practice, Stevens published his arguments as a forty-three page pamphlet, in 1812. In addition to this magazine, Stevens had direct connection with England. John Cox Stevens, visiting England to patent his father's multi-tubular boiler in 1805, purchased an order of books for his father and visited Watt, in an effort to persuade the inventor to build high-pressure steam engines. Stevens' plans to visit England in 1810, like Stephenson's emigration, never materialized. English engineer, Marc Isambard Brunel, who aided in the construction of Stevens' first steamboat in 1798, and Stevens were correspondents in 1810.

Between 1815, and 1823, Stevens secured legislative permission to construct railroads from the Delaware to the Raritan Rivers, in New Jersey, and from Philadelphia to Lancaster, Pa. In 1820, he petitioned the Pennsylvania Legislature to build a line from Philadelphia to Pittsburgh. Four years later, he patented the application of his tubular boiler to the steam locomotive. By 1826, Stevens built and operated a locomotive on a circular track at his Hoboken estate, the first constructed and operated in America. Stevens' citation of the successful railroad operation at Hetton, in England, the same year, shows that he was keeping himself informed of progress abroad. John Stevens lived to see his predictions come true. The work that his sons accomplished in carrying out his ideas will be noted later.

Railroad articles in *Rees' Cyclopedia*, by a Doctor Anderson, read as a boy, inspired Philadelphian George W. Smith to visit England in 1820, expressly to study its railroads. In the next four years Smith printed six editions of three assays on his observations and had given away two thousand copies. Through Smith's efforts these essays were reprinted in seventy American papers and periodicals. Several were even reprinted in Europe. The *Berks and Schuylkill Journal*, of Reading, Pa., the nearest city of size to Pennsylvania's Southern Anthracite Coal Field, reprinted Smith's ideas on the superiority of railroads over canals, just as the Schuylkill Navigation was opening in 1825.

Smith's predictions before 1824 of locomotive speeds above fifteen miles per hour, while modest compared to those of John Stevens, brought severe criticism, especially after Wood's 1825 English edition told American purchasers that twelve miles per hour was the top speed to be expected. Smith, in editing an 1832 American edition of Wood, refers to six English publications for more current information than the original work presented: three magazines, two encyclopedias, and publications of the Highland Society. It is in this work that Smith claims the pioneer 1804 locomotive, built by Vivian and Trevethick, was copied from the plans of Philadelphian Oliver Evans, when his agent to England displayed them to engineers in 1794-95. Smith further claims that he proposed a railroad from the Potomac to the Ohio, in

1824, but that, at the same time, he predicted a line from Philadelphia to Pittsburgh could be built at less cost.

James Renwick (1792-1863), Professor of Natural Sciences and Experimental Chemistry at Columbia College, New York City, was another American who credited Doctor Anderson for rousing his interest in railroads. Born in Liverpool, Renwick was brought to New York by his emigrating-merchant father, who maintained trading relations with Liverpool. The presence of Liverpool papers, letters from his father's commercial correspondents, and English scientific magazines may be taken for granted in a home with this background. Renwick graduated with highest honors in his Columbia class of 1801. After working for the United States as a topographical engineer, he became an instructor at Columbia College in 1812. In 1820, he began his career as professor, a position he held until 1853.

In addition to the influence Professor Renwick may have had on turning the interest of engineer Horatio Allen, a Columbia graduate of 1823, and the first man to operate an English locomotive in the United States, toward railroad building, he contributed information on inclined planes to an 1823 New Jersey Canal Prospectus, which was printed in two editions. Recognition for this work came to Professor Renwick three years later in the form of an eighteen-page pamphlet issued by Franklin Institute. The Delaware and Hudson Canal Company employed him as a consultant in November, 1827, on their railroad. In 1828, he edited and made additions to an English work, Lardner's *Popular Lectures on the Steam Engine*. The popularity of this work caused three additional editions, two in 1836, and the last in 1838. Renwick's own *Treatise on Steam Engines* was issued in 1830 and 1838. A work more directly linked with railroads was his 1831 comparison of costs between the Mohawk and Hudson, New York State's pioneer railroad, and a canal.

The Charleston (S.C.) *City Gazette* carried a letter proposing the railroad as a means to gain for that city a better position in the cotton trade, as early as Nov. 22, 1821. Although signed "H" and credited to Senator Robert Hayne, this early stand for railroads was probably motivated by Robert Mills (1781-1855), a pupil of Latrobe. The year before, this South Carolinian circulated his proposals (in a hundred-page pamphlet) that the Washington, D. C.-Pacific Coast trip could be cut to sixty-five days, by a rail or turnpike road over the Rocky Mountains, between the headwaters of the Missouri and the Columbia. In 1821, Mills declared that the Charleston, S. C.-Pacific Coast trip might be made via canals, rivers and a railroad over the Rockies, in sixty-two days. This same year a model railroad was displayed in Charleston. Speedy mail service between New Orleans and Washington was one of the benefits promised to the Postmaster General, on a timber railroad proposed by Mills in 1827.

Active in the pioneer South Carolina Railroads, Mills advocated, in 1828, Stevens' pile-construction, as on the Delaware and Hudson, assumed that locomotives be used, and made a complete estimate of the

whole cost of construction, including locomotives, cars and coaches. A Committee of Inquiry, reporting on Nov. 11, 1828, established correspondence with England, referred to English railroads, English engineers' advice to other American lines, and of the dispatch by other states of American engineers to observe English practice. E. L. Miller, Charleston merchant, elected a director at the first 1828 meeting after the incorporation of the line, sailed to England to observe construction and expressly to see the Liverpool and Manchester Locomotive Trials. The far-reaching results of Miller's visit will be recounted later.

II. AMERICAN VISITS TO ENGLAND

The visits made to England to observe the progress in the railroad, and the effect these visits had in the United States, will be discussed in detail. Some are well known, but the results occasioned by the lesser-known warrant exposition.

An 1824 prospectus of the Liverpool and Manchester Railroad tells of American interest in their line. Evan Thomas, of Baltimore, though not mentioned by name in this prospectus, probably was the American in Liverpool gathering data for a railroad projected between the Potomac and the Ohio. Thomas sent this information to his brother, Phillip E. Thomas, whose interest in railroads had been aroused by accounts of the Stockton and Darlington. William Brown, later an M.P. from Liverpool, about this same time sent information to his brother George, of Baltimore. Together, George Brown and Philip E. Thomas sparked the organization of the Baltimore and Ohio Railroad in 1827. Baltimore also obtained the most accurate and latest railroad information through their relations with English commercial houses.

Moncure Robinson (1802-1891), son of a Richmond, Va., merchant, studied engineering both at home and in Europe. While observing the public works of England, between the years 1825-1828, he met and became well acquainted with George Stephenson. Upon his return he worked as engineer on the Allegheny Portage Railroad of the Main Line of Public Works of Pa., the Little Schuylkill Railroad in the Schuylkill County Coal Fields, which purchased English locomotives by 1833, the Danville and Pottsville, all in Pennsylvania, as well as on the Chesterfield Railroad and the Petersburg and Roanoke in his native state. In addition to the railroads in Pennsylvania, Robinson surveyed the "Catawissa Route," later the Little Schuylkill and Susquehanna Railroad, between the Upper Schuylkill, the Lehigh and the Susquehanna Rivers, and the proposed Nescopec Canal route between the Upper Lehigh and the Susquehanna Rivers. After locating an extension of the Little Schuylkill Railroad to Reading, Pa., in 1833, he laid out, during 1834-1836, the final rail link between the First Anthracite Coal Field and Tidewater, the Philadelphia and Reading Railroad.

Moncure Robinson returned to England, in 1836, to secure an English loan to complete the Philadelphia and Reading Railroad to Mt. Carbon, in the First Anthracite Coal Field, and to purchase eight locomotives from Braithwaite, Milner & Co., of London. These eight-ton 0-4-0 engines, arriving in the United States between 1838 and 1841, were

the last of the early locomotives imported from England by any American railroad. One, the "Rocket," survives at Franklin Institute in Philadelphia. The loan came from the London bankers Gowan and Marx, who had heavy investments in American railroads. The Philadelphia and Reading honored these financiers by naming a Robinson-planned 4-4-0, the "Gowan and Marx." Built by Eastwick and Harrison, of Philadelphia, this engine established its builder's reputation by bringing 423 tons from Reading to Tidewater. Seventeen publications on railroads, written by Robinson between 1829-1838, survive today.

The Pennsylvania Society for the Promotion of Internal Improvements, in 1825, sent architect and engineer William Strickland (1784-1854), a pupil of Latrobe, and his assistant, Samuel H. Kneass, to gather facts on English canals and railroads. Upon his return, Strickland recommended that Pennsylvania construct railroads rather than canals. "Canal fever," the completion of the Schuylkill Navigation, and the near-completion of the Union Canal, linking Philadelphia with the Susquehanna River, caused the Pennsylvania Canal Convention of 1825 to vote down the engineer's railroad proposals as too impractical. Strickland's trip created the railroad sections of the Pennsylvania Public Works, the Philadelphia and Columbia and the Allegheny Portage Railroads. Later, Strickland engineered the Wilmington and Susquehanna Railroad, part of today's Pennsylvania Washington-New York Line.

Kneass, Strickland's assistant and the creator of the drawings for Strickland's *Report*, became the 1828 engineer for another pioneer Schuylkill County anthracite road, the Mine Hill and Schuylkill Haven. This line fed its tonnage into the Schuylkill Canal. The next year English experience was carried to Kentucky's pioneer line, the Lexington and Ohio, by this engineer. Like Robinson and other early engineer visitors to England, Kneass made a return visit in 1840, to observe the latest improvements and methods on the English railroads. In the United States, after his return, he practiced his profession on the Philadelphia and Trenton, the Philadelphia and Wilmington, (sections of the Washington-New York Pennsylvania line today) the Pennsylvania and the Northwestern Pennsylvania.

An English locomotive made a trip over an American railroad before the 1829 Rainhill Trials on the Liverpool and Manchester. Had the track construction equalled English standards, or the locomotive been built nearer to their specified weights, Stephenson's success would have occurred a month after the Honesdale trials on the Delaware and Hndson Canal Company Railroad. Because of this occurrence, Horatio Allen's visit to England was the most momentous of the railroad inspections made by Americans, from 1820 to 1844.

Influenced by newspaper accounts about the locomotives of the Stockton and Darlington, Horatio Allen (1802-1889), American born, Columbia-trained engineer on the sixteen-mile railroad of the Delaware and Hudson Canal, resigned his job that he might observe English railroads. Just before he sailed, the D. & H. commissioned him to purchase locomotives and rail for their line.

However, English influence on the Delaware and Hudson antedates Allen's visit. Benjamin Wright (1770-1842) recommended on May 21, 1825, before the September, 1825, opening of the Stockton and Darlington, that a railroad rather than a road be built over the Moosic Mountains, between the Delaware and Hudson Canal terminus and the Susquehanna Valley. Early in his career he secured "from abroad [England] the best books, maps and instruments" for his own instruction. Wright boldly made this recommendation for a railroad "without a qualifying clause for his own protection."

The Delaware and Hudson acted on Wright's recommendation, in the spring of 1827. John B. Jervis, the new chief engineer, began his survey on April 4, and completed it October 24, 1827. A Pennsylvania railroad was in operation ahead of this survey, Josiah White had opened his Mauch Chunk Railroad in the Lehigh Valley in May, 1827, a much-publicized line, which repaid its cost in fourteen months. Jervis recommended the use of six- or seven-ton locomotives on the eleven miles of trackage between inclined planes. He estimated that seven locomotives would cost $12,600, but this cost would soon be repaid by saving the company $30.50 daily, by eliminating the use of horses and by carrying coal at the rate of .018 per ton-mile. Basing their action on Jervis' figures, the managers decided, on January 16, 1828, to commission Allen to buy English track iron and four locomotives, specifying that the engines should be capable of four miles per hour, to have four or six wheels, with a gauge of 4′3″. Jervis had based his recommendations on English engineers and engineering publications. The Jervis Library at Rome, N. Y., today possesses in his personal collection three titles of Tredgold's works, the Edinburgh Encyclopedia, and Encyclopedia of Royal Engineers, and other early publications bearing London imprints.

Jervis, while engineering on the Saratoga and Schenectady Railroad, suggested, from experience gained with the imported Stephenson locomotive used on the Mohawk and Hudson Railroad, that a pivoting, four-wheel front truck replace the non-flexible, front pair of wheels. This arrangement, which allowed long-wheel-base, English-type engines to negotiate the sharp curves of American lines without derailment, was adopted by George Stephenson on the "Davy Crockett," the first locomotive to operate on the Saratoga and Schenectady, on April 6, 1833.

The West Point Foundry built the first locomotive with this improvement, in 1832, for the Mohawk and Hudson, where it made a mile in forty-five seconds. Baldwin, Norris, and Eastwick and Harrison quickly adopted this flexible truck to their great profit. Herapath, in England, quotes Stevenson, in 1839, as saying that this American locomotive improvement was ingenious.

Horatio Allen left New York on January 24, and arrived at Liverpool on February 15, 1828. (This was before a B. & O. group, which followed, left America.) Six days later, he met George Stephenson "with whom he immediately established most agreeable relations; receiving from him every kindness and all the aid he could render." Allen visited the Liverpool and Manchester, the Stockton and Darling-

ton, and Newcastle, the center of locomotive and railroad matters. At Stourbridge, he received rail bids from Foster, Rastrick and Co., and in the Welsh iron regions from the Guest Iron Works, at Merthyr Tydvil, the scene of Trevethick's 1804 locomotive trials.

On July 19, Allen reported to the Delaware and Hudson Company that he had contracted with Robert Stephenson and Co., of Newcastle, for a locomotive, the "Pride of Newcastle," and for three with Foster, Rastrick & Co., of Stourbridge. The Stephenson engine left Newcastle on October 20, 1828, on the ship "Columbia," and arrived in New York on January 15, 1829, at a delivery cost of $3,633.30. After assembly at the foundry of Abell and Dunscomb, 375 Water Street, it was demonstrated under steam (on blocks), on May 27, to the great amusement of crowds attracted by the novelty of a steam locomotive.

The "Stourbridge Lion" left Stourbridge in February, 1829, Liverpool, on April 8, aboard the "John Jay," and arrived at New York, May 13. Landed at the wharf of the West Point Foundry at the foot of Beach Street, the "Stourbridge Lion" was set up at this company's shop under the direction of William Kemble. After a demonstration under steam, on June 11, 1828, which attracted thousands, it and the "Pride of Newcastle" were sent up the Hudson, arriving at Roundout on July 4. The "Lion" arrived at Honesdale and the railroad before July 23.

On the morning of August 8, 1829, two months before the Rainhill Trials of the Liverpool and Manchester, Engineer Allen and the "Stourbridge Lion" made the first trip on a commercial railroad in the New World. A second trial of the same locomotive followed on September 9. Engineer Allen later expressed the belief that had the Stephenson locomotive, (the "Pride of Newcastle," modeled on Stephenson's winner, the "Rocket") been prepared for the trials at Honesdale, Pa., rather than the "Stourbridge Lion," the U. S. would have had the glory of the first successful locomotive trial rather than England. However, the light track structure was unable to carry the burden of the overweight, operating locomotive, and as a result these four pioneer English locomotives never hauled coal for the Delaware and Hudson Canal Company. D. & H. stock dropped from $82 to $74 per share when news of the unsuccessful trials reached Wall Street by the middle of August, 1829.

Horatio Allen had been hired by the South Carolina Railroad as chief engineer, early in the summer of 1829, but his duties did not begin until September. He worked for that pioneer line until 1834. After a three-year visit to Europe, Allen become engineer of the New York and Erie Railroad. These roads, the longest in the world when projected, though built on the pile system advocated by John Stevens, in 1811, received English ideas from Allen. That Allen's faith in the locomotive was unshaken, even though the Delaware and Hudson locomotives had failed, was forcibly demonstrated when he convinced the South Carolina Railroad of the value of locomotives, in September, 1829. Further, this recommendation was accepted by the Board without a dissenting vote. If this adoption did take place in September, 1829, then

the South Carolina committed itself to the use of steam before the Liverpool and Manchester Trials, as Allen and others claim. However, the date of adoption may have been January 14, 1830. Allen's arguments were based on Stockton and Darlington costs, and, most effective, a comparison of the expectation of development possible in the steam engine with small chances of improvement in the breeding of horses. One Allen recommendation, however, that a flange rail be used on the line, was not accepted because of higher costs. This type of rail was used only on the few curves of the road.

E. L. Miller, the Charleston merchant, whose interest in the future of railroading drew him to Liverpool to witness the Rainhill Trials of October 6, 1829, returned to Charleston convinced of the value of the locomotive. Earlier, Miller exhibited a thirty-inch-long model, with a boiler holding only a gallon of water, but capable of pulling a man on a circular seventy-foot track, in Charleston, during February, 1830. Backing his belief with action, he made an offer to the Board of Directors of the South Carolina road to personally finance the construction of a locomotive. Upon the acceptance of his proposition by the Board, on March 1, 1830, Miller contracted with the West Point Foundry, who had set up and demonstrated the "Stourbridge Lion" for the Delaware and Hudson, to construct the "Best Friend of Charleston." Designed by C. E. Detmold, of Charleston and New York, the engine was to be capable of ten miles per hour and pull three times it own weight. Miller supervised construction and explained its features to visiting directors during the summer of 1830.

Exhibited under steam at N. Y. before shipment, in October, 1830, the "Best Friend of Charleston" arrived at Charleston on October 22. As no machinist accompanied the shipment, the local firm of Dotterer and Eason assembled the engine. Julius D. Petsch and Nicholas Darrell, apprentices of Thomas Dotterer, had the "Best Friend" ready for experimental trials before November 1. Miller and others made the first trial trip with Darrell as engineer on the next day. The rigid front wheels with wooden spokes, then English style, sprang sufficiently on the curves that the engine derailed. With this weakness corrected, Miller accepted the locomotive on December 9. On trials made on December 14 and 15 the "Best Friend" ran at speeds from sixteen to twenty miles per hour pulling four and five cars, each carrying ten passengers. The railroad purchased the "Best Friend" from Miller on December 24, 1830.

Miller's influence on the locomotive didn't end with this single purchase. He visited Baldwin shortly after that manufacturer's first locomotive, "Old Ironsides," successfully operated on the Philadelphia, Germantown and Norristown Railroad, on November 23, 1832, and suggested that Baldwin visit the Mohawk and Hudson line in New York, to observe the operation of the unpatented, Jervis four-wheeled, pivoting front truck, as a substitute for the pair of rigid front wheels. Baldwin adoption of this design brought an order from Miller for Baldwin's second locomotive, the "E. L. Miller," a 4-2-0 with Baldwin's newly

invented half-crank, a Bury boiler and brass driving wheels. This locomotive was completed February 18, 1834.

In 1834 he patented a method for increasing locomotive adhesion, which threw part of the tender's weight on the rear of the engine. Baldwin first paid $100 royalty per locomotive for the use of this idea, then purchased the rights for $9000, on May 6, 1839.

The "West Point," the second locomotive on the South Carolina Railroad, was also built by the West Point Foundry, but on designs drawn up by Horatio Allen. English influence was reflected in its horizontal boiler. The South Carolina eight-wheeled locomotives, also designed by Allen and built by the same firm, were an American innovation, but their double-valve arrangement was styled after the practice of the Liverpool and Manchester.

The Camden and Amboy Stephenson locomotive, "John Bull," served as a model for the South Carolina's seventh West-Point-built locomotive, the "Hamburg," in 1833. Finally, this line, goaded by its stockholders, imported, in the years 1834-36, fourteen English locomotives to bolster its motive power.

The wreckage of the "Best Friend," after its boiler exploded in June, 1831, was rebuilt by Julius Petsch in Thomas Dotterer's machine shop. Renamed "Phoenix" and having outside connections, straight axles, and cast wheels with wrought-iron tires, this rebuilt engine was back in road service on October 18, 1832. With this construction experience plus that gained in the original assembly of the "Best Friend," Dotterer and Eason ventured to contract for the building of a locomotive for the South Carolina Railroad, on Dotterer's plans, in 1833-34. "Native," the first locomotive built in the South, was the first American locomotive originally built with outside connections and straight axles. Demonstrating great power on its trial trip, the four-ton "Native," after an excruciating delay to its designer, triumphantly returned with the cause of the delay, the disabled regular engine and its train. Horatio Allen praised this Charleston creation for extreme simplicity of operation, direct application of power and substantial workmanship. Costing $4,900, the "Native" earned $187, during April, 1834.

At Charleston, between 1835 and 1837, Eason and Dotterer and Thomas Dotterer built four locomotives for the South Carolina line. In 1838, D. H. Dotterer and Company sent two locomotives to the same road, but, according to the *Berks and Schuylkill Journal*, of Reading, Pa., the "Branchville" and the "Reading" were constructed at Reading, Pa., where the factory was probably attracted by the increasing supply of iron in the Schuylkill Valley. In 1840 Dotterer and Company, employing thirty journeymen and sixteen apprentices and having an annual capacity of twelve locomotives, rebuilt three engines and constructed six first-class locomotives. The State of Pennsylvania purchased eight locomotives between 1839 and 1841, from this builder, six for the State Road from Philadelphia to Columbia, and two for the Allegheny Portage. The "Lycoming," a 4-2-0, sold to the Philadelphia and Reading

Railroad in 1842, is listed as Dotterer's ninth engine. Later this same year, the "Reading," a 4-4-0, followed from the Reading factory, to the same road.

The Philadelphia and Reading Railroad created shops at Reading soon after its 1838 opening. At first this company borrowed Dotterer's experienced workmen to help solve their engine repair problems; as greater repair capacity was needed and more skilled workmen required, the Philadelphia and Reading bought Dotterer's equipment. Thus, Thomas and D. H. Dotterer lost their identity in the gulping expansion of the Philadelphia and Reading locomotive shops, but, in doing so, became, through Horatio Allen and E. L. Miller, an additional link of English influence on the Philadelphia and Reading Railroad.

In 1828, the Baltimore and Ohio Railroad sent engineer Jonathan Knight, inventor Ross Winans, and two West Point-trained engineers, William McNeil, and George W. Whistler, to examine "minutely English track construction and locomotive development on every line of note of consequence." The group left the United States in November, 1828, and returned (except Winans) in May, 1829. During their visit the engineers contacted George Stephenson and other noted English engineers of the day and examined the operating Brunton and Shields and the Stockton and Darlington railroads. The construction of heavy stone bridges and stone-slab rail was the chief immediate result to the Baltimore and Ohio, while the whole United States benefited from the English experiences of this four-man tour.

Whistler, at the conclusion of his work on the Baltimore and Ohio, engineered the Baltimore and Susquehanna (June, 1830), the Paterson and Hudson (1831), the Boston and Providence, and the Providence and Stonington, and also served as consulting engineer on the Western Railroad of Massachusetts. McNeil built the Long Island, the Taunton and New Bedford, the Boston and Worcester, surveyed the South Carolina-sponsored, never-built Charleston, Louisville and Cincinnati and worked with his brother-in-law Whistler on the Providence and Stonington. Knight spent his professional life, until 1842, as chief-engineer of the B. & O., with B. H. Latrobe as his assistant. By 1840 both Knight and McNeil had published eleven pamphlets and reports on railroads.

Like Charlestonian E. L. Miller, Ross Winans was much more than a passive spectator at the Rainhill Trials. He was the first American to contribute to English railroading; his car axles with outside journal bearings were used on the Liverpool and Manchester early in 1829. Unlike engineers Knight, McNeil and Whistler, Winans spent an entire year in England investigating railroads, locomotive and car construction and negotiating for the English use of his axle and journals.

The B. & O., after considering the reports on English locomotives by Knight, McNeil and Whistler, and the opinions expressed by engineers in England, had decided that these rigid large-wheeled locomotives with long wheel base were unsuited for their sharp-curved line. Stockholder Peter Cooper thought otherwise, as did Winans. Active in the

formation of the B. & O. since January, 1828, Winans, upon his return to Baltimore, in addition to the construction of the first eight-wheeled passenger car, assisted Cooper in the building and trial operations of Cooper's "Tom Thumb." This tiny engine, weighing less than a ton, with thirty-inch wheels and a wheel base of about five feet, or little more than the track gauge, made a trial run in 1829. After adjustments, the "Tom Thumb" forcefully demonstrated, on August 28, 1830, its ability by taking the sharp curves of the Baltimore and Ohio at fifteen miles per hour, and pulling four-and-a-half tons. Winans reported the "Tom Thumb" results to President Thomas of the B. & O., in a letter the day of the trial. Comparing the performance to the Rainhill Trials, (and mentioning that he had seen them) Winans credited the "Tom Thumb," in proportion to its cylinder capacity, with three times the power of Stephenson's "Rocket." This was possible because Cooper used high-pressure steam. Further, Winans held that this trial established the practicability of the use of locomotives on the Baltimore and Ohio.

Winans was the Baltimore and Ohio's Assistant Engineer of Machinery at the time that line held its own "Rainhill Trials," advertised on January 4, 1831, to take place June 1, 1831. Number four of the nine conditions specified a four-foot wheelbase to suit short curves. Like Rainhill, only one of the four locomotives, the "York," performed to the specifications of the contest. Built by Phineas Davis and Israel Gardner at York, Pa., the winner was similar to the "Tom Thumb" in that it had the short wheel-base and an upright boiler. Steel springs were an 1832 innovation on this locomotive.

After the accidental death of Davis, Winans with George Gillingham, a Baltimore and Ohio Superintendent of Machinery, succeeded, in 1836, to the 1834 lease of the Mt. Clare shops to Davis and Gardner, by the Baltimore and Ohio. (In the meantime, Winans is credited with aiding the original firm in the construction of the locomotives, the "Atlantic," in 1832, and the "Traveler," in 1833, at York, Pa.) For several years Gillingham and Winans, with a hundred-man labor force, repaired B. & O. equipment on a cost-plus basis, as well as building locomotives for other roads. However, the Baltimore and Ohio had first call on their production, at $5000 per engine, should the need arise.

Winans patented, on July 29, 1837, an upright-boilered locomotive, with four coupled drive-wheels, propelled by horizontal cylinders. The advantages claimed for this short-wheel-base engine were the lower center of gravity, better rail adhesion and greater facility to negotiate sharp curves. In about fifteen months the partners built six of these ten-ton engines and, in 1838, two weighing over fourteen tons for the Baltimore and Ohio. All were the patented type, best known as "crabs," because the cylinder-propelled spur shaft, which was geared to the drivers, revolved in the opposite direction to the pinion shaft and the driving wheels. The Philadelphia and Reading, being built to carry anthracite to tide, probably because his engines burned anthracite, bought, in 1837, the Winans-built "Delaware." This "crab"-type 0-4-0 locomotive was

the first engine to arrive at Reading, Pa., the city soon to become a railroad and locomotive-building center. Three twenty-ton 0-8-0 vertical-boilered "crabs," built by Baldwin on Winans' design, went to the Western Railroad of Massachusetts.

Meanwhile, the Baltimore and Ohio used upright-boilered locomotives exclusively. The 1836 delivery of the English-built "Tennessee" to the Winchester and Potomac Railroad, a line branching off the Baltimore and Ohio at Harpers Ferry, into Virginia, attended with recurring derailments on curves, convinced the management of the correctness of their opinions regarding horizontal-boilered engines. Rumors that Pennsylvania was about to discontinue the use of a hundred-thousand dollars worth of English engines clinched the argument. This report was partly true; Baldwin's better performing locomotives were replacing their English rivals.

A change of great importance in the motive power ideas of the Baltimore and Ohio occurred in 1837, under the leadership of a new president, Louis McLane. Between 1838 and 1843, the line purchased fifteen 4-4-0 locomotives from Eastwick and Harrison, and William Norris. The "Philip E. Thomas," built by Norris in June, 1838, was the first horizontal-boilered engine on the Baltimore and Ohio. More direct English influence in design was the locomotive "Arrow," an inside-connected (inside cylinders and driving rods) 4-4-0, built by the Newcastle Company of Delaware. Other far-reaching occurrences during the presidency of Louis McLane will be related later.

All Winans' engines to this time had vertical boilers, which permitted a very short wheel base, but now he had to adopt the English horizontal boiler. After building three horizontal-boilered 4-4-0s for the Baltimore and Ohio, between 1843 and 1845, he placed a horizontal boiler on an 0-8-0 with his "crab" running gear. This engine, nicknamed a "mud digger," was a predecessor of Winans' famous 0-8-0 "camels." Twelve "mud diggers" were built between 1844 and 1846, for the Baltimore and Ohio. In 1847, the Philadelphia and Reading, again because they desired anthracite burning locomotives, purchased four thirty-ton Winans 0-8-0s with a short 11′ 3″ wheel base. The "Baltimore" came to the P. & R. in June, 1847. Performance is reflected by the $2000 bonus which the P. & R. gave Winans.

Forty-three sisters followed to the Reading between 1850 and 1855. The Baltimore and Ohio purchased three of these Winans 0-8-0s in 1848, naming the first the "Camel," because its cab was placed on top of the boiler, not to the rear, thus naming his new-style locomotive. Ten additional followed during 1851, and the company built two in its Mt. Clare shops. By 1858 this line owned 119 of these powerful Winans freight haulers. On May 9, 1854, Winans received a patent on the large firebox and grates, features of the "Camels," which made him a large fortune. He retired from the locomotive business after 1860.

Philadelphia soon felt the results of Baltimore's 1828 engineer excursion to England. While the Baltimore and Ohio was deterred for nine years, by its sharp curves, from the purchase or manufacture of

locomotives on the English style, Colonel Stephen H. Long (1784-1864), engineer on that pioneer line from 1827 to 1830, was sufficiently impressed by the English experiences of Winans, Whistler, McNeil and Knight, that he began to manufacture locomotives in 1830; the same year he co-authored with McNeil a two-volume report on Baltimore and Ohio engineering. Colonel Long, when he received a Pennsylvania charter for his American Steam Carriage Co., in March, 1830, began the construction of his first locomotive, in Philadelphia. Modeled on English design, with several improvements, (one perhaps on his own patent of 1826) this three-and-a-half ton engine operated with varying degrees of success on the Frenchtown and Newcastle Railroad, in Delaware. The July 4th, 1831, trial was disappointing; a shortage of steam did not permit a continuous two-mile run. The next day, the engine propelled two passenger coaches, with some seventy persons, four miles, and had fifty pounds of steam at the trip's end. Long brought the locomotive to Philadelphia, to build a new boiler. Trials at Newcastle, on Oct. 31, 1831, were again disappointing. Alone, the engine would travel at twenty-five miles per hour, but it could not pull a load. Joseph Harrison, Jr., who soon after this time worked for Long, held that this locomotive would have been successful had Long "more faithfully copied" his English model.

Philadelphian William Norris (1802-1867) built a steam carriage which attracted the attention of Colonel Long. Disregarding his own failure, Long entered partnership with Norris in 1832, and, while the firm lasted only three years, the later success of Norris and the Philadelphia locomotive builders, which developed out of this partnership, was phenomenal. The "Black Hawk," the firm's first product, operated on the Philadelphia, Germantown and Norristown in 1833. An inside connected 2-2-0, it had a novel boiler with seven-foot flues. Its single pair of four-and-a-half foot drivers were located ahead of the boiler. Discarding Stephenson's steam exhaust as a means of creating a firebox draft, Long substituted a twenty-foot smoke stack, which could be retracted to clear low bridges. Long and Norris built four duplicates of the "Black Hawk" during 1834. In this year Norris bought out Long.

Norris, hiring skilled mechanics to replace the mechanical and engineering know-how lost in Long's departure, produced several mediocre-performing locomotives on designs which had proved successful with other locomotive builders. However, Norris came up with a winner in his 1836 "George Washington," a 4-2-0 with four-foot driving wheels located ahead of the firebox. On July 19, 1836, this six-and-three-quarter ton locomotive climbed the 187-foot-high Belmont Plane on the west shore of the Schuylkill River, with two cars and fifty-three passengers. Only two minutes and twenty-four seconds were consumed in this half-mile climb on a grade of 369 feet to the mile, a rate of 15½ mph.

Herapath's English *Railroad Magazine*, after reporting this accomplishment, dismissed the American feat as "utterly impossible." This same magazine, in reporting that Norris had sold to Austria eight-ton locomotives capable of pulling 309 tons on level track, said sarcasti-

cally, "No engine will draw more than twenty-eight times its own weight. [224 tons] . . . Unless, therefore, the laws of nature be different in America to what they are in England, we venture to say the stated performances of Philadelphia engines are impossibilities." The 1837 purchase of seventeen Norris locomotives by the Birmingham and Gloucester Railroad reflects Norris's reputation in England, rather than Herapath's statements.

Harrison, the long-Norris employee already mentioned, held that the "George Washington" was "an heir of the earlier efforts of Colonel Long," and explained that this amazing performance was made possible by an adjustment of the tender draw bar, which threw extra weight on the rear of the locomotive, thus greatly increasing traction. With the success of the "George Washington" Norris became famous; he successfully built locomotives for the next thirty years. Septimus Norris, a brother, patented a ten-wheel locomotive, the 4-6-0, in 1846.

In 1835 Garrett and Eastwick, Philadelphia steam engine and machinery manufacturers, received an order to build a locomotive for the Beaver Meadow Railroad, the first rail line in the Lehigh Valley to use locomotives. Garrett, who, as a manufacturer of lathes, had employed machinist, Joseph Harrison, Jr., during the years 1832-33, now rehired him as foreman of the new locomotive factory. Harrison had spent the years away from Garrett working as a machinist for Long and Norris and Norris and Co. In 1837, with twelve years of machinist experience behind him, Harrison became a partner in the firm.

The company's first locomotive, "Samuel Ingham," was a 4-2-0 with outside cylinders; its driving wheels were behind the firebox, and the boiler was the domed Bury type. Eastwick used for the first time on this engine his newly patented method of reversing a locomotive, which was easy to build and effective in operation. Another first was the use of a covered rear platform for the protection of the engineer and fireman. The success of this locomotive brought orders for duplicates.

In 1836, Henry Campbell, of Philadelphia, patented the use of four driving wheels on a locomotive, placing one pair before and the other behind the firebox. Using this patent, Garrett and Eastwick built a fifteen ton 4-4-0, "Hercules," in 1836-37, for the Beaver Meadow Railroad. Eastwick also applied to this engine his patented center pivoting frame, an improvement which allowed the four driving wheels to adjust themselves easily to the inequalities of the light track of that day. The Beaver Meadow track structure from Parryville, on the Lehigh Canal, to Beaver Meadow, consisted of 5″ x 7″ wooden rails, capped with 2¼″ x ⅝″ iron; ties were three feet apart where the wooden rail consisted of 5″ x 7″ timbers, and four feet center-to-center under 5″ x 8″ rail. An underlying mudsill of 2½″ thickness and a width of 10″ or 12″ was beneath the ties and under the rails. With its weight so well distributed, this track supported the (nearly) four ton per axle of the "Hercules." Another Eastwick patent, an improved firebox, was noted in England by Herapath, in 1839.

Harrison, a junior partner in 1838, patented, that year, an improvement on Eastwick's frame, an equalizing lever, which supported the driving wheels, which was simpler, lighter and cheaper to build. In a very short time all locomotive builders were paying Harrison royalty on this improvement.

This was the stage of locomotive development when Moncure Robinson ordered the "Gowan and Marx" from Eastwick and Harrison. To meet the specification that this locomotive carry nine of its eleven tons on its drivers, Eastwick & Harrison moved the rear axle to a point just in front of the center line of the firebox. With a five-foot firebox, a Bury boiler, 2″x5′ flues and 42″ diameter drivers, this engine handled 423 tons, forty times its own weight, on Feb. 20, 1840, from Reading to Philadelphia at nearly ten miles per hour. The Philadelphia and Reading immediately ordered ten duplicates from the Locks and Canals Company, of Lowell, Mass. The successful performance of the "Gowan and Marx" attracted the attention of Russian engineers inspecting American railroads for their government. Upon their offer, Harrison visited Russia, in 1843, and, with Thomas Winans, a son of Ross Winans, contracted, as Harrison, Winans and Eastwick, to build locomotives for the Russian government, in Russia. Eastwick and Harrison closed their Philadelphia plant in 1844.

Visits to England, which were of great importance to the United States, continued after the Rainhill Trials. The Stevens-backed Delaware and Raritan River, for which New Jersey legislative approval had been secured on February 6, 1815, was revived as the Camden and Amboy R. R., within six months after the L. & M. success. Robert L. Stevens, the Colonel's son, visited England, met and established friendly relations with George Stephenson, attended the trial of his new-type locomotive, the "Planet," on December 4, 1830. Designed as a freight engine, the "Planet" carried the first freight, fifty-one tons, between Liverpool and Manchester. In this lading were 135 bags and bales of American cotton. Two days later, Stevens ordered a reproduction of this engine, the important and famous "John Bull," which made its first run on the Camden and Amboy, on November 12, 1831. Of equal or greater importance was the incentive the "John Bull" presented to American mechanics. Robert Stevens also purchased English-made rails for the Camden and Amboy while on this trip. Made on his own design, this rail, 39 pounds to the yard, was the beginning of the American "T" rail, which, unlike the English, was laid directly on the ties, thus saving the cost of chairs.

Solomon White Roberts (1811-1882) was present at the birth of the railroad in Pennsylvania, having assisted his uncle, Josiah White, in building the 1827 Mauch Chunk Railroad. After locating the Portage Railroad of the Pennsylvania Main Line of Public Works across the Alleghenies, Roberts visited Welsh and English iron districts to inspect rail being rolled for the Philadelphia and Reading Railroad. In addition to English railroad practice, Roberts brought information about the new Welsh hot-blast iron reduction using anthracite coal. The

Thomas Iron Company was instituted in the Lehigh Valley, in 1839, as a direct result. As the Lehigh Coal and Navigation helped finance this furnace to increase its freight income, so the Lehigh Valley R. R. interests later aided in the construction of the blast furnace of the Bethlehem Iron Company. To credit the presence of Bethlehem Steel in the Lehigh Valley today to Roberts' visit is not outside the realm of potentiality.

Through Roberts' visits English influence reached several railroads. He worked on the Little Schuylkill and Susquehanna as chief engineer, in 1838-39. This pioneer line attempted to link the Schuylkill, Lehigh and Susquehanna Valleys, and is today divided into the Reading Company's Catawissa Branch and part of the Lehigh Valley's Quakake line. In 1848 Roberts surveyed an extension of the 1828 Mine Hill and Schuylkill Haven Railroad to Ashland, in the second Anthracite Field, and, finally, he built and managed the Ohio and Pennsylvania Railroad, now the Pittsburgh-Crestline, Ohio, portion of the Pennsylvania Main Line to Chicago.

One of the last visits to England by early American railroad men was that of politician, financier, and diplomat Louis McLane. McLane became president of the Baltimore and Ohio in 1837, and directed expansion westward and financial operations for a decade, and, as already mentioned, adopted English-style locomotives, thus forcing Ross Winans to drop his use of the upright boiler. McLane had been Minister to England, (1829-1831) served in Jackson's cabinet as Secretary of the Treasury (1831-1834) until the president's dispute with the Bank of the United States, when he was shifted to the State Department. Upon his retirement from public service in 1834, he became president of the Morris Canal and Banking Company of New Jersey.

McLane brought added transportation and financial know-how gained in this combination banking house and transportation company, which, with the Biddle Pennsylvania-chartered Bank of the United States, controlled a paper canal and railroad route extending from New York, via the Lehigh River, through the Susquehanna Valley, into Western New York, and from Philadelphia, via the building Philadelphia and Reading and the completed Little Schuylkill Railroads. After building and operating an anthracite-carrying canal from Newark to the Lehigh River's junction with the Delaware, at Phillipsburg, N. J., these companies financed railroad construction from the Lehigh, via the Beaver Meadow and the Little Schuylkill Railroads, to Catawissa on the North Branch, and Williamsport on the West Branch of the Susquehanna, through today's Carbon and Schuylkill counties. The Williamsport and Erie Railroad was to extend this line towards Erie Canal and the projected New York and Erie Railroad. In the financial smash-up following the Panic of 1837 and the crash in 1841, funds of Indiana and Michigan, whose bonds the Morris Canal and Banking Company had purchased on credit and marketed, were so involved in the partly-constructed Little Schuylkill that both states were forced to default their interest payments and refinance their state obligations largely owned in England.

McLane in an initial effort to extend the Baltimore and Ohio from Harpers Ferry to the revenue-producing Cumberland Coal Fields, ordered engineers Knight and Latrobe to make a survey of locomotive operation and track construction of American railroads. This resulted in the adoption of the horizontal, English style locomotive by the Baltimore and Ohio, as already related. As president of the Baltimore and Ohio, McLane twice visited England. In 1840 he arranged with Baring Brothers a special issue of 6 percent bonds (issued June, 1842) to finance the rails necessary to reach the coal field. Seven shiploads of fifty-four pound English rail enabled the line to reach Cumberland by November 5, 1842. Thus, McLane and Barings enabled the Baltimore and Ohio to increase its income, not only to meet interest on these special rail bonds, but also to pay dividends on stock owned by Maryland and Baltimore. These dividends in turn aided Maryland to resume interest on her bonded debt largely held in England. The Baltimore and Ohio was one of the few state-sponsored enterprises at this time able to meet its interest out of its own revenues. McLane returned to England in a dual role in 1844. In addition to unsuccessful efforts to secure more financial aid to the Baltimore and Ohio, he served as U. S. Minister for the settlement of the Oregon Question. A detailed study of English railroads, made by him at this time, resulted in a management plan for the B. & O., which lasted for years.

III. THE PRESENCE OF ENGLISH LOCOMOTIVES IN AMERICA

English-built locomotives were a direct and indirect influence on American railroad activities. Not only did they eventually prove their own practicability, but their very presence became a challenge to American ingenuity. The building of locomotives by the West Point Foundry, after that company's experience in setting up the "Stourbridge Lion," has been recounted, as has Jervis' invention of the four-wheeled, pivoting truck, which enabled locomotives to manipulate the sharp curves of most lines.

Matthias Baldwin, founder of the Baldwin Locomotive Works, builders of locomotives today near Philadelphia, began his career as an apprentice jeweler and opened a shop of his own, in 1819. As the demand for jewelry fell off, he shifted into machinist work in partnership with David Mason. Unsatisfied with the operation of a steam engine purchased to power their shop, Baldwin built an engine on a very compact design. Occupying only a space five feet square, it was natural that orders for similar engines followed.

To capitalize on the great public interest of the time in locomotives and railroads, Franklin Peale, proprietor of the Philadelphia Museum, requested Baldwin to construct a model locomotive. Relying only on the descriptions and sketches of the Rainhill Trial locomotives as a guide, the machinists completed the model capable of drawing four persons, and had it operating on a circular track in the museum, on April 25, 1831. This demonstration of constructive skill brought Baldwin

an order for a full-scale locomotive from the Philadelphia, Germantown and Norristown Railroad. About this same time the Newcastle and Frenchtown Railroad, the line linking the Delaware and Chesapeake Bays hired Baldwin to assemble two Stephenson locomotives. On this assembly job Baldwin gained experience through handling parts of English locomotives in the latest design and of the best workmanship. Further, as a skilled mechanic, he had the opportunity of making accurate measurements and drawings. In addition, the Philadelphian visited Bordentown, N. J., to inspect the unassembled "John Bull," modeled on Stephenson's "Planet." The Frenchtown and Newcastle experiences and a memoranda of principal dimensions of the "John Bull" served Baldwin well in the construction of "Old Ironsides." A close copy of the Frenchtown and Newcastle English engines, Baldwin's locomotive performed successfully, making about twenty-eight miles per hour, on November 23, 1832, and later thirty with its usual train. Baldwin had introduced at least one improvement of his own on his initial engine; the reverse gear was not copied from the English models. However, Baldwin's second locomotive, the already discussed "E. L. Miller," had a "Bury" or haystack boiler, an English design used on all Baldwin locomotives until 1850.

One of the five locomotives completed by Baldwin, in 1834, was the "Lancaster," a 4-2-0 duplicate of "the E. L. Miller." The ability of this engine to handle nineteen loaded cars across the grades of the State Railroad between Philadelphia and Columbia, on the Susquehanna, convinced the Pennsylvania State Legislature to adopt steam power. Two duplicates began work on this railroad later this same year.

Four Baldwin improvements, patented in 1834, were applied to that year's production: a half-crank drive which employed the wheel itself as the other half, making crank construction much simpler; a new method of constructing wheels; ground joints for steam pipes, which replaced the canvas and red-lead used on English engines of this time, enabled Baldwin to use 120 pounds of pressure compared to the English sixty; and an easy-to-clean feedwater pump which was built into the piston-rod guide. These improvements gave Baldwin's locomotives such a degree of efficiency that the Stephenson engines on the State Railroad were either laid aside or sold. The "Blackhawk," one of the fourteen engines built in 1835, was the first Baldwin locomotive to have outside-connected drivers, as well as the first upon which Miller's patent for increasing track adhesion was used. Baldwin began the standardization of parts, the great feature of the American machine age, on his 1839 locomotives. The outside frame was discarded on his hundred and thirty-sixth engine, and the eight-wheeled tender was first used this year. Baldwin's 1842 invention of the flexible-beam driving truck, which enabled a heavier six-coupled driving-wheel locomotive, (an 0-6-0) to safely negotiate sharp curves, and pull a greater load, brought him financial success at a time when he verged on failure. As Eastwick and Harrison had done, Baldwin bought patents of others. E. L. Miller's has been mentioned several times. In addition, he purchased,

in 1845, the rights to Campbell's eight-wheeled engine and Eastwick and Harrison's equalizing beam. Thus equipped, he built his first eight-wheeled locomotive in 1845.

Beginning with number one, "Old Ironsides," Baldwin saw his production reach a thousand in 1861. His company was well on its way for the second thousand, achieved in 1869, when its founder died in 1866.

The career of George W. Whistler has been traced through his engineering life in the United States except for one facet, that as a locomotive builder. While managing the Proprietors of the Locks and Canals, of Lowell, in 1834, Whistler reproduced a British locomotive, which the Boston and Lowell Railroad had imported. Whistler, as the Baltimore and Ohio had sent himself nearly a decade before, sent an employee, Burt, to England to observe Stephenson's latest operations. Whistler having contracted to construct railroads in Russia, left the Lowell locomotive plant in 1837.

English influence in several forms enters the story of the New Jersey Rogers Locomotive Works. Starting a chain of reaction was the first locomotive to be operated on the Whistler-engineered Paterson and Hudson Railroad, the English-built "McNeill." As the West Point Foundry adapted from the pioneer Delaware and Hudson locomotives, Baldwin from the "John Bull," and Whistler from the English locomotives of the Boston and Lowell Railroad, so Engineer Swinburne, with the aid of English-trained mechanical draftsman Hodge, drew from the "McNeill." Both men were employees of the manufacturing firm of Rogers, Ketchum and Grosvenor of Paterson, N. J., whose sole railroad experience, until this 1835 incident, had been the construction of a hundred sets of wheels for the South Carolina Railroad, on a contract from Horatio Allen.

Sixteen months later number one of this firm emerged as the "Sandusky," and became, when sold, the first locomotive owned by the Ohio pioneer line, (other than the Michigan-built Kalamazoo and Erie) the Mad River and Lake Erie. When the "Sandusky" arrived at Sandusky, Ohio, November 17, 1837, aboard the schooner "Sandusky," there was no track built; its gauge, 4′ 10″, set the standard for the owning line and the State of Ohio. Rogers' notable improvement on this locomotive over the "McNeill" was the first use of counterbalanced driving wheels. Rogers built seven additional locomotives in 1837. Englishman Hodges, while visiting his homeland in 1847, sent the Rogers Company a drawing of Robert Stephenson's unpatented 1842 link-motion valve control, which became a standard on Rogers locomotives. This transmittal, however, was not the movement of an English practice across the Atlantic, but the return of American innovation first used by William T. James, of New York, in 1832. Rogers' locomotive "Stockbridge," this same year, pioneered with outside cylinders.

William S. Hudson was even a closer link between Rogers and England. After working as an apprentice and working for Stephenson, in Newcastle, Hudson emigrated to America. From the position of

Master Mechanic with the Attica and Buffalo Railroad, he moved to Paterson as superintendent of the Rogers Locomotive Works. In 1864 Hudson patented a method of equalizing the springs of the front pair of locomotive driving wheels with those of a two-wheeled leading truck, thus securing a three-point suspension for the engine. Both Rogers and Baldwin used this device. It is fitting to add that Engineer Swinburne, who helped initiate Rogers and Paterson, N. J. into the locomotive business, Alger-like, became the proprietor and operator of his own locomotive works. It is sad to relate that he lost most of his fortune in the railroad-inspired depression of 1857.

IV. ENGLISH RAILROAD MATERIAL REPUBLISHED IN THE UNITED STATES

In addition to the several English publications already mentioned, London newspapers and magazines carried the latest railroad information to United States subscribers. George W. Smith's English-inspired articles appeared in seventy American papers. A steady stream of reprints of English materials, sponsored by the Federal and State governments, societies, cities, and railroad companies, flowed from the press before and after the 1829 Rainhill Trials.

Two 1825 treatises on railroads came across the Atlantic in quantities too small for the demand. An American edition of Tredgold's work was reprinted in New York the same year as it appeared in London, while Carey and Lea, Philadelphia publishers of many railroad pamphlets during this period, reissued Wood's book in 1832. Editor George W. Smith, in bringing this work up to date by his own comments from current English sources and chapters on American railroads, criticised the canal policy of Pennsylvania and predicted the absolute necessity of linking and extending the state-owned railroads to Pittsburgh, even before the hybrid canal-rail system began operations. In 1826 Carey and Lea reproduced the two-volume work of English Civil Engineer John Nicholson. A revised American edition followed within five years.

The hunger of the American public for the most recent information from England is reflected by the two editions of Strickland's single letter and a September, 1825, Liverpool and Birmingham Railroad Report which his Society issued in the same year. Three editions, within two months, of a railroad pamphlet, based on material from an essay by the Highland Society of Edinburgh, further illustrates this desire. Carey and Lea published Strickland's 1826 Report of fifty pages, and accompanied it with a six-page resume.

There was no sectional monopoly in this progressive work; the 1825 Virginia House of Delegates ordered Grahame's London edition on railroads and canals to be republished in Richmond. The preincorporation organization of the Baltimore and Ohio reported, on Feb. 19, 1827, that 2000 miles of completed and building English railroads had convinced many Englishmen and Americans that railroads would supersede canals, as the canals had replaced turnpikes in England. The

spokesman for American canal interests, the Chesapeake and Ohio, whose route paralleled that of the Baltimore and Ohio up the Potomac Valley, and a competitor for Maryland financial backing, issued and circulated adverse facts on the English lines. These often were printed in the same volume as the pro-railroad facts. House of Representatives Document No. 101 is an example. The canal side accused the Baltimore and Ohio of gathering its 1827 arguments from Thomas Gray's *Observations on a General Iron Railroad.* Though this work warranted five English editions by 1825, seemingly it was overlooked by American publishers. Columbia Professor Renwick's four editions of Lardner's work, from 1828 to 1838, needs to be recalled in this classification. Apparently, shortly before Rainhill, the Baltimore and Ohio, in a probable effort to justify its calls for city, state, and national aid, publicized, in 1829, the results of English railroad experiments, without mention of the Trials.

Stephenson's success at Rainhill, in October, 1829, which the United States was "anticipating . . . with eager hope," found this country "ripe to accept the results." Though the locomotive was now generally accepted in the United States, the Liverpool and Manchester results, magic words, were called to the attention of the American public for another decade.

Josiah White, the builder of the 1827 Mauch Chunk railroad in the Lehigh Valley, in a letter of May 18, 1830, referred to an article on Liverpool and Manchester locomotive operating costs, which appeared in the London *Mechanics Magazine* of October, 1829. Part of White's letter and the reference to the Liverpool and Manchester were reprinted in a congressional document.

Massachusetts described the Liverpool and Manchester locomotive success story in an 1830 Internal Improvement Report, and, the same year, Paterson, N. J., reproduced an accurate description of it in a thirty-page pamphlet, as an argument for the success of their proposed railroad to the Hudson River. John Stevens' son, Edwin, made reference to a Liverpool and Manchester Report in Mar. 1830. To satisfy a public demand, Carey and Lea, in 1831, included a description and additional L. & M. facts in a 206-page book. The next year Congress republished accounts of the Liverpool and Manchester dating from both before and after Rainhill, in Document 101. Two years later the same body cited Liverpool and Manchester costs in a pamphlet favoring the construction of the Illinois and Michigan Canal.

Not all accounts were favorable. The Chesapeake and Ohio Canal and its friends seized upon both the locomotive upkeep costs and track damages reported by the Liverpool and Manchester as arguments for building canals. The South Carolina Railroad recorded in their motive power investigations English accounts of 1831, which told of the great repair expense for Liverpool and Manchester locomotives, and that usually only one-third, six or seven of twenty-four owned, were fit for use. Horatio Allen made a comparison with the locomotive weights of the L. & M. in determining the one-and-a-half ton axle weight limits for

the South Carolina line. A South Carolina report two years later told that six months' repair and maintenance of the L. & M. locomotives cost $52,910, which, including track repairs made the yearly cost $175,000. Working and repair cost of locomotives was $4000 per mile a year. However, in spite of the very high costs, the dividend paid was twice the usual rate of interest. Despite these startling figures, the South Carolina Railroad continued to order additional American-built locomotives, and, from 1834 to 1836, imported fourteen British locomotives for their road. The 280 per cent advance in the Liverpool and Manchester shares was used, in 1835, to promote the sale of the proposed Louisville, Cincinnati and Charleston Railroad.

A description of the L. & M. and other writings of Nicholas Wood and George Stephenson came to America, via France in an 1833 translation printed in Boston. One of the last English items to cross the Atlantic for reprinting was the twenty-page 1835 Report of the Grand Junction Railroad, which linked Liverpool with Birmingham. While the Thomson list of 2671 surviving American publications continues through 1840, this citation is the last mentioning the Liverpool and Manchester or English railroads. From the great frequency of their use, the words Liverpool and Manchester really were magic to the American publisher and reader of railroad information.

English recognition of American railroad progress came in the 1838 London publication of David Stevenson's *Sketch of Civil Engineering in North America*. A member of a famous engineering family, David Stevenson had worked on the Liverpool and Manchester, while his uncle was of sufficient repute in English engineering circles, in 1825, to be quoted four times by Wood. Written after a professional tour of the U. S. and Canada, this work of 320 pages, fourteen plates, and a map warranted a five-page review in *Herapath*.

V. BRITAINS AND BRITISH CONSTRUCTION IN THE UNITED STATES

The railroad caused a movement of men from its inception; Irish laborers helped build the 1828-29 Liverpool and Manchester and the early lines of Scotland. Horatio Allen had been authorized to engage two English locomotive engineers to superintend Delaware and Hudson locomotive operation, but there is no record that Englishmen came to America with either the Stephenson or the Foster and Rastrick locomotives. Englishman N. Cummings, who had eighteen months locomotive experience with Stephenson's four-wheeled Liverpool and Manchester engines, accompanied the famous Stephenson engine, "John Bull," to the Camden and Amboy Railroad. In addition to working on this New Jersey pioneer line, Cummings ran a six-wheeled engine on the Baltimore and Susquehanna Railroad, before moving on to the South Carolina Railroad by 1833. Engineer Wm. Robinson, (or Robertson) long-experienced with the L. & M. four-wheel locomotives and backed with a Liverpool and Manchester recommendation, likewise came to America with a Stephenson engine, and was working for the South

Carolina Railroad in 1833. Of the two English engineers, who accompanied the Bury-built locomotives, purchased by the Little Schuylkill Railroad in 1832-3, one returned to England shortly after the locomotives were placed in operation. George Mann never returned to England, but worked many years on the Little Schuylkill between Port Clinton and Tamaqua, Pa. William Hudson, apprentice and workman at Stephenson's Newcastle factory, has been mentioned in connection with the Rogers Locomotive Works.

The largest notable movement of men into the United States, occasioned by boom-time railroad construction and the labor shortage during the Civil War, is an illustration of the boom-time railroad operations by the great English railroad contractors, employing as many as 30,000 men. Sir Morton Peto, often, as other great contractors did, built railroads, and, after construction ended, ran the railroad until companies he organized bought the line. Peto, with other British contractors and financiers, brought his engineering and financial skills to the United States, to build the Atlantic and Great Western Railroad, today's main line of the Erie Railroad from Salamanca, N. Y., to Marion, Ohio.

James McHenry, a former Philadelphia merchant, who became a British-American railroad financier, used money-control of the English *Railroad News* to "hysterically promote" the Atlantic and Great Western. Publicized as a six-foot gauge link between New York City and St. Louis, and between the Erie and the Ohio and Mississippi Railroads, both well known and partially owned in England, McHenry built the road without investment of his own funds; on paper he made ten million dollars. By pledging stock to London banks for ninety-day bills, as publicity created their demand, he began his campaign. A million dollars worth of 7 per cent bonds, issued at eighty, sold well because the Bank of London guaranteed payment of the first four coupons. Other bonds, issued at fifty cents on the dollar, paid for 55,000 tons of English rail.

Spanish financier and politician, Don Jose Salamanca, added prestige and credit to the line by taking the first building contract. Banks in Liverpool and London turned Salamanca promises into cash. Under McHenry's direction British engineers began work; Sir Morton Peto moved on to the job. In spite of the Civil War shortage of labor, fifteen thousand laborers, one-third of them English, completed the road. By late 1864 trains ran between Salamanca, N. Y., and Dayton, Ohio. A third rail on the Cincinnati, Hamilton and Dayton Railroad, Dayton to Cincinnati, completed the connection between New York and St. Louis, by a six-foot gauge line. This amazing construction had cost McHenry 50 per cent in London and these debts cost 10 percent. However, he lost no money on his contracts. With a capitalization of sixty millions, bonds at fifty per cent brought McHenry thirty millions, while the road cost twenty. He could make ten millions, providing he could unload the new line quickly. In 1865, Sir Morton Peto and a group of British capitalists visited the United States in an effort to dispose of the Atlantic and Great Western. The bankrupt

Erie, resisting threatened competition, refused to purchase. The Baltimore and Ohio, which already connected with the Ohio and Mississippi, declined to buy a duplicating connection. Unable to earn its interest, the Atlantic and Great Western had to be supported by its bankers. Its 1866 failure revealed stock manipulations similar to 1928 operations in the U. S.

Leases and contracts for lines in eastern and central Pennsylvania, one through Bethlehem, made before the Atlantic and Great Western failed, show that Sir Morton Peto attempted to secure a New York outlet for the line. The Morris and Essex Railroad from N. Y., to Phillipsburg, N. J., and the Catawissa, Williamsport and Erie, (today's Reading line from near Tamaqua to Williamsport, and the Little Schuylkill) were leased. A railroad was to be constructed by the Philadelphia and Reading-controlled East Pennsylvania Railroad, from Phillipsburg, through Easton and Bethlehem, to its own line at Allentown. The Philadelphia and Reading, then financed by English bankers McCalmonts, was to finish the nearly-completed Allentown Railroad to the Philadelphia and Reading, at Port Clinton, from the East Pennsylvania line. Two railroads through central Pennsylvania, the Western Central and the Lewisburg Centre and Spruce Railroads, were to be constructed by the Atlantic and Great Western, between the Catawissa terminus, at Williamsport, and Oil City, Pa.

The Philadelphia and Reading actually began work on the Allentown Railroad, completing the road to Kutztown, Pa., but the Atlantic and Great Western failure ended construction. The partially graded right-of-way and an uncompleted tunnel may still be seen and easily traced in southern Lehigh and northern Berks Counties. The corporation of this line existed until War II, when it was merged into the Reading Company. English financial control of the Philadelphia and Reading lasted almost to the twentieth century; another English influence ended on May 12, 1890, when left-hand operation on double-track line ceased.

Upon the failure of the Atlantic and Great Western, a London family bank, Bishoffsheim and Goldschmidt, reorganized the road for McHenry. Later, this same bank cleaned up the Erie Railroad by ending Jay Gould's management. Other casualties of this American railroad venture by English capital, were the London Joint Stock Bank and Overend, Gurney and Co., known as the bankers' bank, as early as 1807. Thomas Richardson, backer of the great firm of Overend, Gurney and Co., had financed railroads before 1824. Then he furnished his cousin, Pease, with capital to complete the Stockton and Darlington, and, in 1824, he and Pease furnished part of Stephenson's capital to begin the Newcastle Locomotive Works.

VI. ENGLISH RAIL AND FINANCE IN THE UNITED STATES

"Rails and capital . . . the United States could not fully provide for itself." When the financial demands of the railroad rose after 1829, the United States turned to England for capital as she had for decades. Shares and bonds flowed across the ocean in greater amount than ever

before, to pay for English rail, locomotives and trans-Atlantic freight charges. Money in the period 1828-32 being cheap, 1½ per cent in London, the 5 to 10 percent American state securities, financing banks, canals, and railroads, were quite attractive to British investors. However, some slave-hating purchasers refused to buy bonds of the Slave States despite the high interest. Scare-buying came from fearful Tories, who converted English investments into American bonds during the Reform Bill discussions, as protection against the coming wrecking of England. Moreover, these English investments in the United States were made while there was a great demand for capital in England's own railroads; the success of the Liverpool and Manchester influenced Parliament to authorize $190,000,000 capital, between 1830 and 1837.

Baring Brothers and Company, one of the dozen big British merchant-banking firms competing for the purchase of American cotton and grain, as well as American securities, sold $27,000,000 of state bonds at home by 1830. In 1832 Barings purchased Pennsylvania, Ohio, and New York bonds, and, reflecting their faith in certain states, publicly linked their name with the securities of Louisiana, South Carolina, Maryland, and Massachusetts. South Carolina borrowed $2,000,000, in 1838, for its Southwestern Railroad Bank, a pre-Civil War southern banking stronghold, which controlled, at this time, the pioneer South Carolina Canal and Railroad Company, and which was proposing a railroad to Cincinnati. Barings, in financing half this loan, sent $500,000 specie to South Carolina. Once Barings publicly connected their reputation with a state, they went to considerable lengths to protect that reputation. To keep control of Maryland bonds, this firm bid 117 for a 6 percent loan in 1835. Other costly efforts to keep their shield untarnished will be told later.

Active competition existed among the British financial houses. Barings lost the purchase of Pennsylvania State bonds financing rail purchases, by a ½ percent bid of an English competitor, but won the Massachusetts bonds and rail sales for the Boston and Providence, the Boston and Lowell and the Western Railroads. However, the biggest competitor to all foreign houses was Nicholas Biddle's Bank of the United States. Biddle information gave a large Pennsylvania issue to Gowan and Marx, later the English financiers of the Philadelphia and Reading. This Biddle competition was partly possible because Barings, while the agent in England for the Bank of the United States, had recommended and sold 80,000 bank shares to their own customers, and, in 1836, lent it $5,000,000. However, Barings refused to invest in the Morris Canal and Banking Company, later a Biddle associate.

Securities of private companies as well as state bonds attracted English investment very early. Stevens' Camden and Amboy, the Harrisburg and Lancaster, the Philadelphia and Reading, (hauling coal to the sea as did the money-making Stockton and Darlington) as well as the early lines in the Lehigh Valley, the Hazleton Coal and the Lehigh Coal and Navigation companies, were particularly owned in England, in the late 1830's. The Baltimore and Ohio claimed to have marketed

the first American railroad loan in England, $500,000, sent to Brown, Shipley & Co., of Liverpool.

The advent of the railroad brought a heavy demand for iron rail on both sides of the Atlantic. W. and I. Sparrow, of Wolverhampton, England, rolled the Delaware and Hudson 2¼″ x ½″ iron to Allen's specifications and shipped much rail of his design to other railroads in the United States. The Delaware and Hudson had sufficient rail by November 5, 1828, to loan the Baltimore and Ohio five tons. The Baltimore and Ohio wrought-iron rail cost $58 a ton delivered, compared to American bids of $92. The state of Pennsylvania, before 1832, purchased ten miles of strap rail, 2¼″ x ⅝″ x 15′, which was laid on stone rail, (as the Baltimore and Ohio) and 76½ miles of rolled edge rail, 41 pounds to the yard. This edge rail, similar to T-rail, costing $50.50 a ton at Philadelphia, was mounted in chairs, as the English use today, on stone blocks or wood ties. The Philadelphia, Germantown and Norristown purchased a Clarence-type rail, also chair-mounted, 36 pounds to the yard. Stevens' T-rail, 16′ long and 39 pounds to the yard, cost about $40 a ton in England.

State aid to the construction of railroads, as by Maryland and Ohio, or outright state construction and ownership, as in Pennsylvania, Michigan and Indiana, was taken for granted in the 1830's. Hopefully, both the undeveloped new states and the older coastal states expected that internal improvements would not only be able to pay the interest on funds borrowed to construct them, but also to earn a surplus income which could be applied to ordinary government costs. Though Federal aid had been sought and denied, requests for tariff rebates on imported rail were frequent. The Delaware and Hudson and the South Carolina Canal and Railroad Co. presented petitions to Congress on April 7, 1838. The latter effort saved $17 a ton on their rails, through a reduction from a flat $30-a-ton charge to 25 percent ad valorem. Based on this rate, the South Carolina company paid $22,000 duty out of the $109,453 cost delivered at Charleston.

Five 1828 petitions to Congress about English rail illustrate the bitter trade rivalry between Baltimore and Philadelphia. The latter port countered within the month Baltimore's four petitions; Congress refused to remit rail duty for Baltimore. Seven years later, Pennsylvania requested this same relief, as did the city of New Orleans, the New York and Harlem, the Newcastle and Frenchtown, and the Baltimore and Susquehanna Railroads. The petition of the Alabama, Florida and Georgia Railroad for the same aid in 1838 being denied, that company issued bonds to cover this unanticipated expense. The P. & R. was among the 1838 beneficiaries of such reductions. The total tariff refund on imported rail (England was the sole source), in the decade 1831-41, was $4,800,000. If the rate of collection were steady at the South Carolina payment of 1838, the English exports would be 369,245 tons, at a cost to America of $19,200,000.

In England, home and American railroad demand increased the price of iron 85 percent, from June, 1835, to February, 1836. The

actual orders from abroad were nearly 450,000 tons, 180,000 a year for five years "to supply the demands of a new trade, or 26 percent of that made. The needs of the United States, just to double track the existing 3000 miles, were held to be 714,000 tons, a demand, which without a mile of new construction, would bring in the next seven years $250,000,000 to England. Another estimate declared that the 750,000 tons of rail needed in the United States could only be procured in England. David Stevenson's 1837 survey of American railroads concurred that the rails must come from England even though the United States had the necessary ironworks to manufacture them. In one week's rail order for June, 1838, America placed 10,000 of the 12,000 tons sold. By 1840, the United States was the most important purchaser of England's fastest growing export, which had doubled in the decade 1829-1839. In this last year America bought 68,000 tons of the 131,000 exported; another decade later, 324,000 of the 554,000 tons exported came across the Atlantic.

American demand for iron climbed with the introduction of railroads; the coal and iron business boomed. The iron business concentrated in Pennsylvania near the anthracite fields; plants quadrupled and output doubled. By 1847, twenty-nine iron companies had erected forty-one hot-blast furnaces, with an annual capacity of 125,800 tons, in the Lehigh, Schuylkill and Susquehanna Valleys.

The time was ripe for the American manufacture of rails. The South Carolina Canal and Railroad Company replacement, in 1838, of their 1829 strap-rail with heavier flange-rail from England, at a cost of $440,000 mirrors the potential demand of the existing railroads alone. The Tredegar Iron Works, Richmond, Va., claim to have rolled the first American rail in 1837, and to have furnished the Richmond, Fredericksburg and Potomac Railroad demand in 1838. In 1842, the Great Western Iron Company, on the Allegheny above Pittsburgh, lost money selling rail to an Indiana railroad at $50 a ton. Two years later, British capital set up the Mt. Savage Iron Works, nine miles from Cumberland on the Baltimore and Ohio, expressly to supply the American rail demand. This project, capitalized at $1,600,000 and with 4000 employees, mostly imported, failed by 1847, and brought only $200,000 at a sheriff's sale. Bradshaw's *Railroad Gazette* of England reported, in October, 1845, the Montour Rail Works at Danville, Pa., a Biddle-Morris Canal and Banking Company project, operating around the clock except Sundays. In 1844 these three rail mills had an annual capacity of only 24,000 tons, while the whole annual capacity of the U. S. was 119,000 tons, or only rail sufficient to replace, or build, 1200 miles of railroad.

The dependence of the United States on England for locomotives never equalled that for rail. By 1838 twenty-seven American builders had constructed 238 locomotives, while only 103 English locomotives had been imported. Seven plants in Pennsylvania had built 144 of these 238. This same year, Pennsylvania's railroads operated 130 locomotives on 1913 miles of track.

An 1845 valuation of American railroads ($125,000,000) estimates $26,000,000 had been spent on English rails, and that 250,000 tons of T-rail were needed just to replace the light strap rail then in use. Two years later, twenty New York and New England lines, partly fulfilling this prediction, did import 66,000 tons of English rail expressly to replace strap rail.

After this long excursion into early American rail importation and production it is necessary to return to the financial conditions of 1830. While the prices of all American stocks were inflated during 1833-34, the 1835 rise in wheat prices brought new faith and a flood of railroad bonds. After being bullish up to 1832, Barings are credited with "relative caution and a restraining influence" on the expansion of English-American trade from 1832 to 1836. In the latter year America owed England a trade balance of $20,000,000; English-American trade had doubled. In the same period American state debts rocketed to $66,000,000 by 1835, and to $124,000,000 by 1837. Fuel to the expansion flames was the promised distribution of the Federal surplus among the states during 1837. Of the $42,000,000 surplus, $37,000,000 was to be given out. Actually only $28,000,000 was distributed. Some states, North Carolina in particular, now entered into state-finance of internal improvement on account of this distribution. In addition to over-expansion of banking and transportation facilities, there was heavy speculation in land and cotton. Southern lines paid for English rails with cotton at this time.

When cotton fell 25 percent in February and March, 1837, the financial crisis set off by Jackson's Specie Circular and the war on the Bank of the United States, plunged the U. S. into a panic. Every bank in the nation suspended specie payment by May. But, to England, this was only a financial crisis in the American Trade, involving, by June, the suspension of seven American-British banking houses. The demand for American securities ceased.

In England the railroad boom moved upward. While the United States suffered deflation, the Stockton and Darlington dividends rose from $55 on a $500 share to $90, in 1838, and the value of a share more than doubled to $1300. Fearing overproduction and low prices in 1839, Staffordshire iron makers co-operated to cut production 20 percent for six months, but renewed English and, later, American demands made the cut unnecessary.

With the revival of American business, state debts climbed to $175,500,000, by the end of 1839. New securities and refunding issues to pay interest on older bond issues cascaded on the American and British money markets, passing chiefly into English hands. To protect their customers to whom they had sold Bank of the United States stock and to bolster this bank, in 1840, Barings made a six-month million dollar loan, taking as security $2,250,000 in 5 percent Mississippi and over a million 6 percent Michigan bonds, received by the Bank from the Morris Canal and Banking Company. Biddle had out-bid his American and British rivals, in 1838, for Alabama and Michigan issues.

As Barings had bolstered Biddle's Bank, now they maintained their own good reputation and Pennsylvania's credit by paying the January, 1840, interest on that state's bonds. When the Bank of the United States collapsed in February, 1841, American bonds fell to their lowest figures. However, Barings endeavored to market Massachusetts, Ohio, and Alabama bonds until July, 1842, when Pennsylvania and Maryland gave notice that interest payments would not be made.

Maryland had been paying the interest on her European-held bonds since April, 1840, through Barings. The bank paid the January, 1842, interest out of their own funds but refused to act as props after the July interest was defaulted. August, 1842, was the greatest depth of this depression; American securities sold only at very low prices.* Having complete control of Massachusetts, Ohio, South Carolina, and Maryland bonds, Barings kept these issues off the market to prevent greater damage to the credit of these states and to protect their own reputation.

To the English investor, after the interest default by nine states, the whole United States was a nation of swindlers. Shrewd English investors, willing to pick up good securities at bargain prices, circulated rumors that all American states would repudiate. British merchants sent these low-cost American securities across the Atlantic in payment for cotton and grain during the next five years. An attempted financial boycott, the refusal of a loan to the debt-free Federal government, by English capital, in 1842, failed because reviving American trade enabled New York bankers to furnish the funds. Proposals by both English and American banking houses that the debt-free Federal Government take over the state debts were disregarded, because of hostility to the source of the suggestion and the campaign of 1840.

Efforts to collect the defaulted interest and to ensure future payment began immediately after the default. When questioned about Federal liability, the U. S. Senate stated that the debt-free Federal Government had no responsibility for the state debts. When Barings asked Daniel Webster about the legality of these bonds, he answered that the individual state had the legal and constitutional power, through the state legislature, to create loans at home and abroad. This opinion, published in England by Barings, had a stabilizing effect on the price of American securities. Other opinions secured by Barings, but not published, held that Pennsylvania would resume payments, and, perhaps Indiana, but little hope was held for the other seven states.

English financiers, Barings in particular, now began to exert direct and indirect pressure on the nine defaulting states to induce them to resume their interest payments. Nicholas Biddle and Daniel Webster were retained by Barrings to influence Pennsylvania to pay her two

* Baldwin's locomotive production well pictures the up-and-down financial condition of both the railroads and the United States in this period:

1835—14	1839—26	1843—12
1836—40	1840— 9	1844—22
1837—40	1841— 8	1845—27
1838—23	1842—14	

millions annual interest. New York banker Ward, another of Barings' American agents, brought pressure on Governor Porter as part of his activities in Pennsylvania, Maryland, Illinois, and Louisiana. Boston, New York, New Orleans, and Baltimore newspapers received $10, or more, for reprinting articles urging resumption. Even the clergy were employed. In the fall of 1844, Webster made a series of speeches in Pennsylvania. After paying the February, 1845, interest, half in cash and half in depreciated bank-notes, Pennsylvania began full payment in 1847.

J. H. B. Latrobe, of the Baltimore and Ohio legal staff, brother of the chief engineer, and the leader of the Maryland Whigs, became Barings' special agent in Maryland. It has been mentioned that this state's bonds had been linked directly with the bank's reputation in Europe. Barings were the official agents for both the state and the Baltimore and Ohio, and held bonds both on their own account and as collateral for loans. It was to keep complete control of Maryland's bonds, that the firm had been forced to bid 117.4 per 100 for an 1835 issue. Likewise, the 1840 visits to England of President McLane, of the Baltimore and Ohio, which enabled the railroad to reach the Cumberland Coal Field and thus pay dividends on the railroad stock held by the state, should be recalled at this point. In spite of repeated calls for resumption by the Baltimore papers, between 1843 and 1845, and the introduction of Latrobe bills in the legislature, Maryland delayed resumption.

The next year, English money aided Governor Pratt to restore Maryland's credit; part of $4500 from Barings talked in the election of the legislature. In a resumption bill, which was passed in March, 1847, the state funded her unpaid interest in 3 percent bonds. By this time, Maryland had borrowed at 5 and 6 percent $6,800,000 to finance railroads and $8,100,000 for canal construction. The Maryland efforts cost Barings $15,000, while costs in Pennsylvania were less than half of that amount. Webster received $100 and a cancelled 1843 note for $2410, *a very small fee* when compared to the annual two millions of interest which Pennsylvania paid. As Secretary of State, Webster gave the United States Fiscal Agency, held by Rothschilds, to Barrings, who retained the post until 1867.

The other repudiating states received little direct pressure for resumption, other than the eastern newspaper articles published during 1843-47 campaign in Pennsylvania and Maryland. A memorial from Barings to the Louisiana Legislature brought interest payments in 1843. Mississippi paid neither interest nor principal. Florida and Arkansas received little attention.

Because Illinois refused to levy a tax to enable resumption, the Illinois Central and the Michigan Central Railroads, even though they favored the tax, lost Barings' favor temporarily. Barings protested to the legislature also when compensation was not provided for the Barings-bonded Illinois and Michigan Canal, as the paralleling Rock Island and La Salle Railroad was incorporated. Ten years later, Barings, with four other English Banking Houses, protested that Wabash

and Erie Canal bonds had degenerated in value because Indiana Legislature had chartered paralleling railroads. England required her railroads to either buy or compensate by paying a certain sum, the canal company whose territory a railroad invaded.

When Michigan sold her railroad lines and issued refunding bonds in 1846 and 1848, Barings received $255,000 for its Michigan bond holdings. As a part of the Morris Canal and Banking Company financial tangle, through which Michigan funds were invested in the Little Schuylkill and Susquehanna Railroad, Michigan temporily owned part of that railroad's anthracite coal lands near Linder's Gap, between Tamaqua and Hazleton, Pa., in Rush Township, upper Schuylkill County. Indiana, who also sold her bonds to the Morris Canal and Banking Company on credit, found herself, through this mismanagement, holding a $1,250,000 mortgage on the canal of the Morris Canal and Banking Company, 13,600 shares of the Little Schuylkill and Susquehanna railroad stock, par value $230,000 but then worthless, and $100,000 stock in the Beaver Meadow Railroad. The most potentially valuable holding of the lot (except New York real estate) was 75,100 shares of the Baltimore and Ohio, then valued at .27 to the dollar. Indiana, by selling her internal railroads, refinanced her debt through Barings and other English bankers.

However accomplished, Barings' six-year program to influence resumption of interest payments enabled the slow-paying states to rescue their good name, and, just as important, to borrow funds from abroad by 1848. One result of this repudiation, a Council of Foreign Bondholders, created in England, survived into the twentieth century.

The 1847 blowup of the speculative English railroad bubble, inflating since 1835, made the average English investor wary of all railroad securities. With diminishing home demand English iron manufacturers felt hard times. Rail prices fell; Welsh rails sold, in 1850, at $27.50 a ton FOB. The memories of the U. S. repudiations of 1842 were revived and reinforced until the 1848 Revolution closed Europe as an investment field. Again, money became cheap, while high American interest rates, 16 percent discount by October, 1851, quickly pushed the bad memories aside. New American construction financed by state, county and city bonds, began in the United States. As security prices recovered in America after 1848, railroad and state bonds were sold back to Americans. Barings held their collateral Baltimore and Ohio and Massachusetts bonds until maturity, while other issues were resold at higher prices. Losses on most American securities were recovered. This recovery ends the story of the Panic of 1837 with its English-finance and American-railroad involvements.

Recovery and low English rail prices attracted large American orders. By 1852 demand forced a 75 percent rise in prices. This year, in spite of the English merchant and banker resales to America, saw $220,000,000 of American securities held abroad. The United States Treasury estimated that $35,500,000 of the $52,000,000 of railroad bonds issued in 1854 were spent for rail. Another spree of expansion, greater

than that of the 1830's, had been set off. As Barings had tapered off purchases in that early inflationary period, the firm again bought cautiously during 1852-1855. In carrying out this policy they allowed their name to be linked only with the few railroads in whose managers they felt great confidence, and favored always the east-west trunk lines and especially avoided roads built in advance of settlement.

The Baltimore and Ohio had met all these specifications, and Barings had given that line the financial aid which enabled it to reach the Ohio River by 1853, an 1849 purchase of 200,000 first mortgage bonds and a shipment of 22,000 tons of rail, partly paid by six-to-ten year bonds. However, the bankers weren't satisfied with the light-track construction to Wheeling, on the Ohio; the Cumberland-to-Baltimore coal rate was too low; while Garrett & Co., who handled Baltimore and Ohio securities, were more expansive and speculative than the bankers desired. In addition, Barings' American advisors foresaw and feared severe Baltimore and Ohio competition with the Pennsylvania Railroad west of the Ohio. All these reasons, as well as friendship with Erastus Corning, of the N. Y. Central, and John Murray Forbes, one of Barings' financial advisors on American railroads, led the bankers to shift financial support from the Baltimore and Ohio to the New York Central.

Erastus Corning, of the original Albany-Buffalo New York Central, warranted Barings' confidence to the extent of a half-million dollar rail credit, in 1853. However, business wasn't forgotten; Barings made 2½ percent on rail purchases, while the interest on the loan was 6 percent. Barings' dependence on American advisors is mentioned in the loss of financial support by the Baltimore and Ohio. In addition to John Murray Forbes, the company at this time received advice from W. H. Aspinwall, William Appleton, William Sturgis, Robert Bennet Forbes, D. A. Neal, W. W. Corcoran and W. S. Wilmore. These men made recommendations on American railroads which enabled the firm to secure bonds safe to offer their customers and which brought credit to them. W. H. Swift, ex-Army Engineer, later president of the Philadelphia, Wilmington and Baltimore Railroad (Pa. Main Line Philadelphia to Washington today) and president of the Western Railroad of Massachusetts, by 1850, became a Baring advisor in 1852. Besides American lines, Swift was consulted by Barings on Canadian and Russian roads.

Their fear of a depression having passed, in 1855, these bankers began investments in Forbes' lines, the Central Military Tract, Chicago and Aurora, Joliet and Northern Indiana, and the Hannibal and St. Joseph, the core of today's Burlington System in Illinois and Missouri. These investments were the last Barings made in American railroads. Sales of rails and purchases of bonds were allowed to pass to competitors. Barings, in addition to attempting to apply the English idea of compensation to canals whose territory was invaded by a railroad, exerted pressure to introduce sound financial methods to their client railroads. In 1858, they refused to purchase Michigan Central bonds, because that company had disregarded Baring advice to create sinking funds for interest and retirement.

By 1857, England had $400,000,000 invested in American Railroads. The panic of that year, as its predecessor twenty years before, was parented by land speculation and over-expansion of railroads. Beginning with a fifteen-dollar-a-share drop in Michigan Southern stock on August 13, speculative securities slid into panic-selling by the 24th. That day, the Ohio Life Insurance and Trust Company, heavily involved in railroad finance, suspended. Within six months discount rose to 24 percent. In the depth of this depression, as in 1837 and 1841, many British buyers purchased depressed American railroad stocks and bonds.

Recovery from the 1857 depression was slow. Railroad loans were only 75 percent of par three years later. In the year Grant took office, 1868, 300,000 tons of English rail came to the United States, and foreign investors, mostly English, despite $12,000,000 lost in the Confederate States, owned one-and-a-half billion dollars of United States railroad securities. In these days of billions, this sum needs comparison with the United States debt following the Civil War to realize its true position. That debt, the astounding sum in its day, of $2,453,000,000 was only 66% more than the foreign railroad investment.

Another English railroad improvement, the steel rail, introduced into the United States during the Civil War, began anew an importation of rail which continued to flow heavily into the United States until 1880. In 1864, two years after the first use of the steel rail in England, the Lehigh Valley Railroad placed steel rail on its Beaver Meadow Division. Naturally, when the Lehigh Coal and Navigation Company decided to extend its Lehigh and Susquehanna Railroad from Mauch Chunk to Easton, after the disastrous flood of 1863, that company utilized the experience of the Lehigh Valley Railroad and ordered English steel rail for the whole distance, though the cost was double that of iron. However, a $5,000,000 bond sale attempted in England near this time, failed to materialize.

Average earnings through dividends and increased market value on English-held railroad securities in the decade 1870-80 demonstrate that American railroads, however financed, built, managed and operated, were the most profitable, paying 9.3 percent to British investors, while Indian lines paid only 6.3 percent and Canadian 2.1 percent.

American expansion drew heavily on England for rail, in 1880, for the last time, when 294,000 tons crossed the Atlantic. Imports fell to only 1800 tons during 1884. The growth of American steel production, especially that of Andrew Carnegie, was responsible for the reversal of this trend. By 1899, Carnegie had so well integrated his holdings of steel plants, coal and ore lands with the cheapest transportation possible, that he was able to deliver steel rail in England at $19 a ton, the English manufacturer's cost, and yet make a profit of three dollars a ton.

British investment in American railroads didn't terminate because heavy rail shipments ended in the 1880's. On the contrary, of the five billions England had invested in the United States in 1914, probably half was in railroad stocks and bonds. A more recent estimate held the

total 1914 British investment in the United States at $3,646,340,000, eighty percent of which, $3,090,000,000, was in railroads. The total valuation of American Railroads at this time was between sixteen and seventeen billion dollars. Hence England was furnishing between one-sixth and one-fifth of the capital of American lines at the outbreak of World War I.

We have observed that the influence of England has been an ever constant factor in the development of American railroads. English ideas brought across the Atlantic by English newspapers, encyclopedias, magazines and scientific papers stimulated Latrobe (his sons and pupils) Stevens and Renwick, the pioneers, advocates and builders. This same whirlpool of publicity drew Philadelphian George W. Smith, Charlestonian E. L. Miller, Baltimoreans Evan Thomas and Ross Winans and engineer Horatio Allen into its vortex to satisfy their curiosity.

Through George W. Smith's efforts seventy American papers broadcast his convictions across the whole land. Today such publicity seems almost sheer waste, but, as in England, American railroad proponents had to overcome canal propaganda. However, the bitterness between the two groups was of greater intensity in the United States because the two modes of transportation, separated by half a century in England, were almost contemporary on this continent. The numerous American reproductions of English railroad statistics, especially those of the Liverpool and Manchester, bolstered the home arguments in this formative period like a footnote citation does a history paper.

The visit of South Carolinan, E. L. Miller to the Rainhill Trials and his later work and personal investments in locomotives produced the first American-built locomotive, and initiated locomotive construction at Charleston, in his own state, and at Reading, Pa. The excursions of many American engineers to England carried English ideas into the whole land and began an importation of English money and rail which flowed into the United States for half a century. While the importing of locomotives from England ended around 1841, their presence was seed in the fertile garden of American ingenuity. Baldwin, Rogers and Norris not only adapted from but also quickly improved on the import. Ross Winans was forced to adopt the English boiler and long wheel base, but his efforts to obtain greater tractive force by keeping engine weight on driving wheels are reflected in today's diesels.

Actual construction by English firms, bankers and men seldom occurred except during the Civil War manpower shortage. Financial aid, as administered by bankers Barings, carried to America the English idea of the sinking fund to retire a bond issue, a feature adopted by the most progressive roads. Attempts to introduce the compensation principle to the railroads competing with the Baring-bonded, state-owned canals in Indiana and Illinois failed, but both New York State and Pennsylvania adopted this idea to protect their canal investment.

All of us recognize the Declaration of Independence as the point in history when the United States declared its political independence from England, the mother country. Even though the American rail-

roads have been practically independent since the beginning of World War I, England, because of the flow of ideas, men, materials and, the longest lasting influence, financial aid, can truly be regarded as the mother of American railroads.

BIBLIOGRAPHY

I. Manuscript Materials and Correspondence.

Loeser Papers, Correspondence received by Schuylkill County lawyer from 1811 on. Historical Society Schuylkill Co., Pottsville, Pa.

Baldwin, Letter from Mr. Paul T. Warner, ex-librarian Baldwin Locomotive Co., Philadelphia, Pa. December 9, 1952.

Jervis. Letter from Miss Helen Salzman, Librarian, Jervis Memorial Library, Rome, N. Y., January 14, 1953.

Whistler. Letter from Mr. Charles E. Fisher, President, Railroad and Locomotive Historical Society, Harvard Business School, Cambridge, Mass.

II. Government and Company Reports.

American State Papers, Documents, Legislative and Executive, of the Congress of the United States, from the First to the Second Session of the Tenth Congress, Inclusive: Commencing March 3, 1789 and Ending March 3, 1809, Miscellaneous I. Washington, 1834.

Leases and Contracts between the Atlantic and Great Western Railroad and the Philadelphia and Reading Railroad. 1868. Railroad Pamphlets, Lehigh University Library.

Memorial of the Holders of Certificates of Stock of the Wabash and Erie Canal of the State of Indiana to the General Assembly of the State of Indiana, March, 1857, London, Washington, New York.

Report of the Board of Directors of the Lehigh Valley Railroad to Stockholders, Philadelphia, Pa.

Report of the Board of Managers of the Lehigh Coal and Navigation Company, Philadelphia, Pa.

Report of the Directors of the South Carolina Canal and Railroad Company to the stockholders, May 6, 1834, Charleston.

Report of the Fund Commissioners, to His Excellency, Samuel Biggers, Indianapolis (?), 184.

Report of Steam Carriages by a Select Committee of the House of Commons of Great Britain. Reprinted by order of the House of Representatives, Document 101, Philadelphia, 1832.

Schuylkill County Grantor Deed Book 23, Pottsville, Pa.

III. Newspapers, Magazines, and Scrap Books.

Annual Register, London, 1805.

Berks and Schuylkill Journal, Historical Society of Berks County, Reading, Pa.

Mansfield Gazette and Richland Farmer, Public Library, Mansfield, Ohio. 28 June 1827.

Philadelphia National Gazette, Philadelphia, 1827.

Readinger Adler, H. S. of B. Co., Reading, Pa.

Bradshaw's Railroad Gazette, London, 1845.

Herapath's Railway Magazine and Annals of Science, London, 1837-1842.

Journal of Banking from July 1841 to July 1842, Philadelphia.

Locomotive Engineer, New York, 1888.

Merchant's Magazine and Commercial Review, N. Y., 1836-50.

Jones Scrap Books, Historical Society of Berks Co., Reading, Pa.

Richard's Scrap Book, Reading, Pa.

IV. Reference Works.

British Museum Catalog of Printed Books, 58 V. Ann Arbor, 1881-1900.

Dictionary of American Biography, 20 V. N. Y., 1928-37.

Dictionary of American History, 5 V. N. Y., 1940.

Dictionary of National Biography, 21 V. London 1908-09.

History for Ready Reference, Springfield, Mass. 7 V. Springfield, Mass., 1895-1910.

National Cyclopedia of American Biography, 37 V. N. Y. 1898-1951.

World Almanac, New York, 1915, 1916.

V. Periodicals.

G. H. Gaskell, "The Origin of Locomotive Class Names," Railway and Locomotive Historical Society, *Bulletin 87*, October, 1952.

George M. Hart, "The History of the Locomotives of the Reading Company," R. & L. H. S., *Bulletin 67*, May, 1946.

Albert H. Imlak, "British Balance of Payments and Exports of Capital, 1816-1913," *Economic History Review* 2nd Series, London, 1952.

John B. Spears, "John Bloomfield Jervis," R. & L. H. S., *Bulletin 30*, Feb. 1933.

Paul T. Warner, "Some Early Locomotive Patents," R. & L. H. S. *Bulletin 87*, October, 1952.

VI. Secondary Publications.

History of the Baldwin Locomotive Works, 1831-1920, Philadelphia, nd.

History of the Delaware and Hudson, A Century of Prograss, Albany, 1925.

Horatio Allen, *The Railroad Era, The First Five Years of Its Development*, N. Y., 1884.

J. Snowden Bell, *The Early Motive Power of the Baltimore and Ohio Railroad*, N. Y., 1912.

Cecil K. Brown, *A State Movement in Railroad Development, The Story of North Carolina's First Effort to Establish an East and West Trunk Line Railroad*, Chapel Hill, 1928.

R. W. Brown, *Some Aspects of Early Railroad Transportation in Pennsylvania, An Address to the Pennsylvania Historical Association*, Carlisle, 1949.

William H. Brown, *The History of the First Locomotive in America from Original Documents and the Testimony of Living Witnesses, Revised Edition*, N. Y., 1874.

J. H. Clapham, *A New Economic History of Modern Britain*, 3 V, Cambridge, 1926.

Samuel M. Derrick, *Centennial History of the South Carolina Railroad*, Columbia, 1930.

H. W. Dickinson and Arthur Titley, *Richard Trevethick, The Engineer and the Man*, Cambridge, Eng., 1934.

Joseph Harrison, Jr., *The Locomotive Engine and Philadelphia's Share in Its Early Development, Revised Edition*, Philadelphia, 1872.

Ralph W. Hidy, *The House of Baring in American Trade and Finance, English Merchant Bankers at Work, 1763-1861*, Cambridge, 1949.

M. S. Henry, *History of the Lehigh Valley*. (Easton, 1860).

Edward Hungerford, *The Story of the Baltimore and Ohio Railroad*, 2 V, N. Y., 1928.

Leland H. Jenks, *The Migration of British Capital to 1875*, N. Y., 1927.

S. M. McCool, "History of Schuylkill County, Pa." Shenandoah, Pa., *Herald*, 1874-75, Photostat of collected columns, Public Library, Pottsville, Pa.

Reginald C. McGrane, *The Panic of 1837, Some Financial Problems of the Jackson Era*, Chicago, 1924.

John B. McMasters, *A History of the People of the United States* from the Revolution to the Civil War, 7 V. N. Y., 1900.

Henry V. Poor, *A History of the Railroads and Canals of the United States*, N. Y., 1860.

I. Daniel Rupp, *History of Berks and Lebanon Counties*, Lancaster, 1844.

Wm. Shultz and M. R. Caine, *Financial Development of the United States*, N. Y., 1937.

Henry Simpson, *Eminent Philadelphians*, Philadelphia, 1859.

Samuel Smiles, *Lives of the Engineers, The Locomotive*, George and Robert Stephenson, London, 1877.

Smith (?), *A History and Description of the Baltimore and Ohio Railway*, Baltimore, 1853.

Charles B. Stuart, *Lives and Works of Civil and Military Engineers of America*, N. Y., 1871.

Fred A. Talbot, *Cassell's Railways of the World*, 2 V. N. Y., nd.

Thomas R. Thomson, *Check List of Publications on American Railroads Before 1841*, N. Y., 1942.

Richard Trevethick, *Life of Richard Trevethick With an Account of His Inventions*, N. Y., 1872.

L. R. Trumbull, *A History of Industrial Paterson*, Paterson, 1882.

A. C. Turnbull, *John Stevens, An American Record*, N. Y., 1882.

George L. Vose, *A Sketch of the Life and Works of George W. Whistler*, Boston, 1877.

John K. Winkler, *The Incredible Carnegie, The Life of Andrew Carnegie, 1831-1919*, N. Y., 1931.

Stephen N. Winslow, *Biographies of Successful Philadelphia Merchants*, Philadelphia, 1864.

Francis Wishaw, *Railways of Great Britain and Ireland*, London, 1840.

Nicholas Wood, *A Practical Treatise on Railroads and Interior Communications in general. Containing an Account of the Performance of the Different Locomotives at and Subsequent to the Liverpool Contests: Upwards of Two Hundred and Sixty Experiments With Tables of Comparative Values of Canals and Railroads and the Power of Present Locomotives, First American from Second English Edition*, George W. Smith, Ed., Philadelphia, 1832.

101 Valve Motions

By Fred Jukes

(Fourth Installment)

This is the fourth and final installment of a history of Locomotive Valve Gears, by Mr. Jukes, and takes into account a number of gears that cannot be properly classed with those described in preceding issues of the Bulletin. It is true that some included here, such as the Bryce-Douglas, the Payton and the Fidler gears, embody some of the principles of the Walschaerts gear, but are not considered true members of the Walschaerts group.

The gears treated in this section appear in the following order, each drawing being numbered, and the description of each gear showing the drawing number.

Bonnefond.
Kirk.
Swan I.
Swan II.
Swan III.
Bryce-Douglas I.
Bryce-Douglas II.
Payton.
Fidler.
Engelmann I.
Engelmann II.
Morton.
Arrol & Pringle Indirect Motion
Arrol & Pringle.
Stewart-Fink.
Thom.
T. F. Redington.
Redington Single Eccentric.
P. L. M. (Walschaerts).
Baguley.
Dodds. Wedge Motion.
Uniflow.
O. W. Young (Corliss).
Loose Eccentric.

BONNEFOND

(Dwg. 50)

Among the large number of locomotives on exhibit in the Transportation Building at the Chicago World's Fair, in 1893, was a French engine that attracted the attention of a lot of railroad men. This was due not to size or foreign appearance, but to a valve gear unlike anything ever seen in this country. At first glance it might have been a variety of Walschaerts' gear, but closer inspection showed two reach rods, two steam chests above each cylinder and a piston-valve chamber beneath.

The locomotive was a 2-4-2 simple passenger engine of the French State Rys., with 17.4″ x 25.7″ cylinders, 79.6″ drivers, and a working pressure of 200 lbs. per sq. in., a high pressure for simple engines at that day.

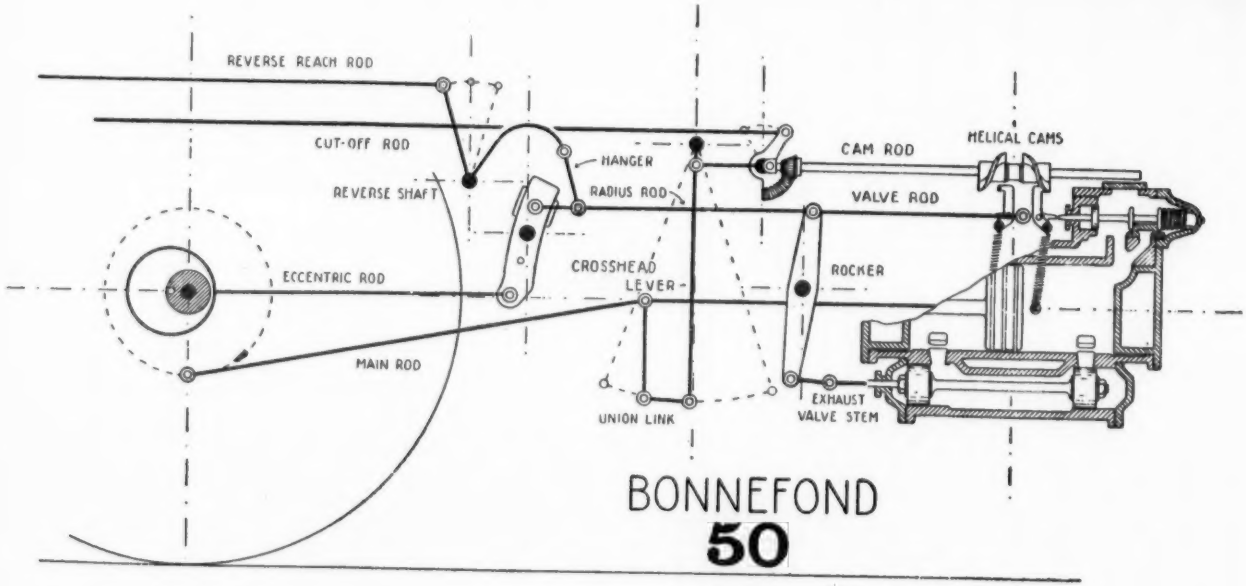
The motion was that of Monsieur Bonnefond, who started experimenting with it in 1885. It gave almost ideal distribution and, aside from an occasional sticking of the admission valves when starting, gave good results, so good, in fact, that a large number of engines on the State Rys., Paris-Orleans and Paris, Lyons & Mediterranean were equipped with it.

The illustration shows the Bonnefond gear in its final stage as shown at Chicago. It is an outside gear with two controlling levers in the cab. One of these connects through the tumbling shaft to the radius rod and is merely for reversing, placing the link block at either the top or bottom of the link when running.

When working at a late cut-off (the position shown) the cut-off lever is moved forward; earlier cut-off being secured by moving the lever toward the back end of the quadrant.

Admission is constant and is operated by the valve rod from the top of the rocking lever, which in turn is moved by the reversing link and radius rod. The lower end of the rocker operates the exhaust piston valves. With compression, admission and exhaust constant, the other phase of distribution, that of cut-off, is the only one whose variation is under control by the engineer.

The forward end of the valve rod carries two small bell-cranks, the tops of which have fingers pointing toward the two helical cams. The tops of these bell-cranks are kept in a vertical position by the two long springs fastened about half way down the outside cylinder walls, until the fingers at the top are moved by coming in contact with one or the other of the cams. In the position shown the valve rod, through the short finger at the center of the forward bell-crank, has pushed the forward slide valve to full opening (the cut-off gear being set for full stroke), and the forward cam will soon tip the top of the bell-crank back. This will raise the end of the central finger from the end of the short valve-stem. The spring just ahead of the valve snaps it back, the recoil being cushioned by a small piston at the other end, this piston being drilled with a small hole which gradually equalizes the pressure.


REVERSE REACH ROD
CUT-OFF ROD
REVERSE SHAFT
HANGER
RADIUS ROD
CAM ROD
HELICAL CAMS
VALVE ROD
ECCENTRIC ROD
CROSSHEAD
LEVER
ROCKER
MAIN ROD
UNION LINK
EXHAUST
VALVE STEM
BONNEFOND
50

When the valve rod carries the bell-cranks back, the forward one resumes its vertical position through the action of the spring. The same cycle of events takes place at the rear end of the cylinder.

Varying the cut-off is accomplished by turning the cam rod by means of a bevel gear so that, when the cams are turned down, the point of valve closure is brought about earlier in the stroke. The slotted cam rod is free to move back and forth, its travel being derived from the cross-head arm and union link.

Exhaust valves, which are below the cylinder, begin to open just before the end of the stroke, and close in time to give the desired compression. Cylinders are jacketed with live steam.

In this motion we have something close to the ideal; a rapid opening of the steam valve, a sharp closing, and a one-way passage of live steam through the steam ports, keeping them hot. Expanded and cooled exhaust steam flows out at the bottom of the cylinder, carrying with it any water of condensation. Constant exhaust and compression are secured, also equal expansion at each stroke of the piston, as the cut-off cams are worked from the cross-head.

It is little wonder that the engines fitted with this gear were economical of steam. Like many another promising gear though, it failed to conquer, its chief drawback being the common one of having too many parts.

Bonnefond's valve motion was contemporary with that of Durant & Lencauchez, another French invention.

KIRK

(Dwg. 51)

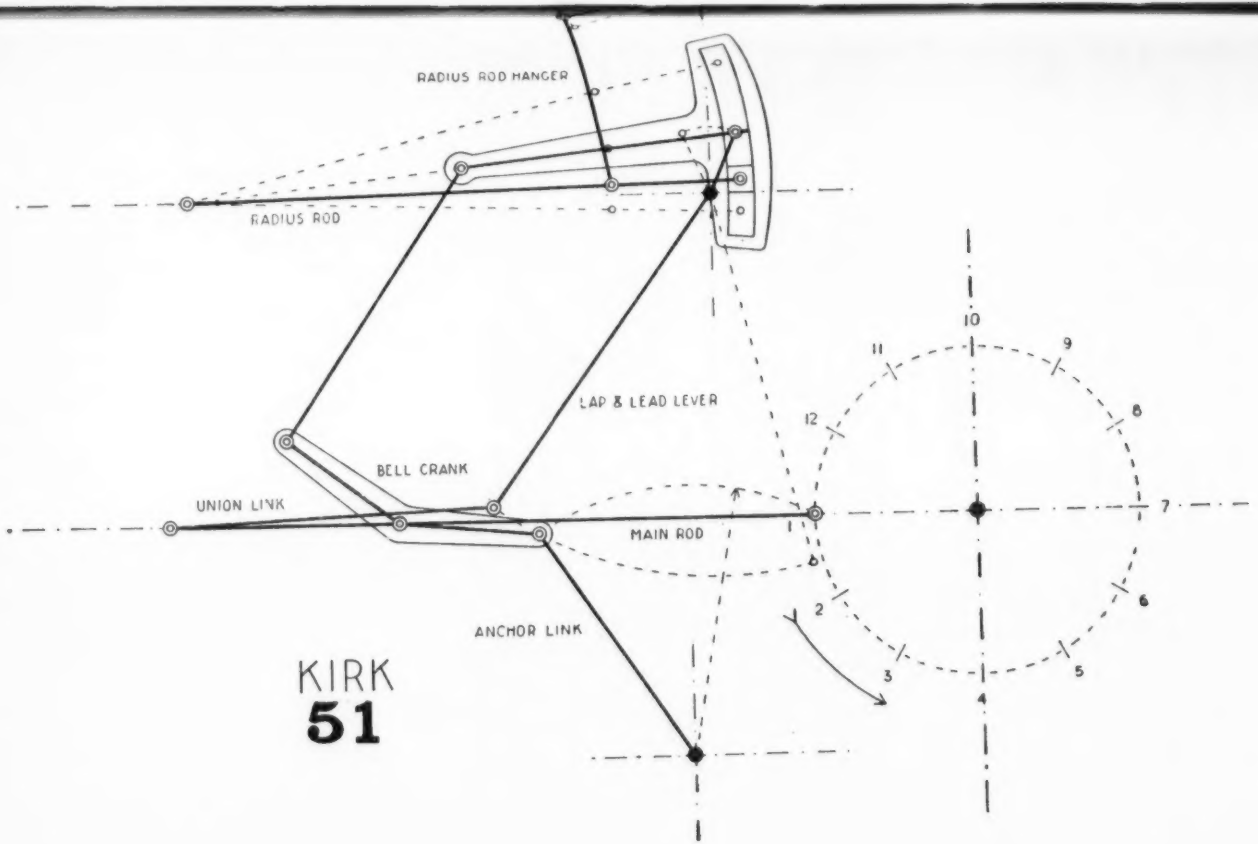
This gear, one of the many variants of the Walchaerts motion, was of Scottish origin. Designed by A. C. Kirk, of Glasgow, it was used in Marine practice, and is shown here because of its radical difference from the usual Walschaerts lay-out.

First, the port opening movement of the link is derived from a bent lever, whose fulcrum is placed toward the front end of the main rod. This, for want of a better name, we will term a bell-crank. It is connected through a rod to an arm integral with the link, thereby giving the latter its usual rocking motion.

Second, lap and lead motion is derived from the cross-head as usual but, instead of being applied to the valve rod in the conventional manner, the fulcrum of the lap and lead lever is a fixed point, while the upper end of the lever carries the link, and moves it bodily through a short arc above this fixed point.

Working out the positions of the link during a revolution of the crank-pin, we find that we have here the same pattern as that given by a link driven by two eccentrics, as in the Gooch motion, though it be driven by neither eccentrics nor return crank.

The so-called bell-crank, and the anchor link to which its lower


RADIUS ROD HANGER
RADIUS ROD
LAP & LEAD LEVER
BELL CRANK
UNION LINK
MAIN ROD
ANCHOR LINK
KIRK
51
10
11
9
12
8
7
6
2
3
5
4

end is attached, are introduced to correct error due to the swing of the rod giving port opening motion to the link. A somewhat different correction to attain the same result was used by Joy in his gear, which was also driven from a point on the main rod. On his small tramway locomotives Kitson used a drive from the side rod. In this case, the lower end of the link rod described a circular path and did not require the rather elaborate means of correction needed here.

As far as the writer is aware, the Kirk gear has not been fitted to locomotives.

SWAN (1)

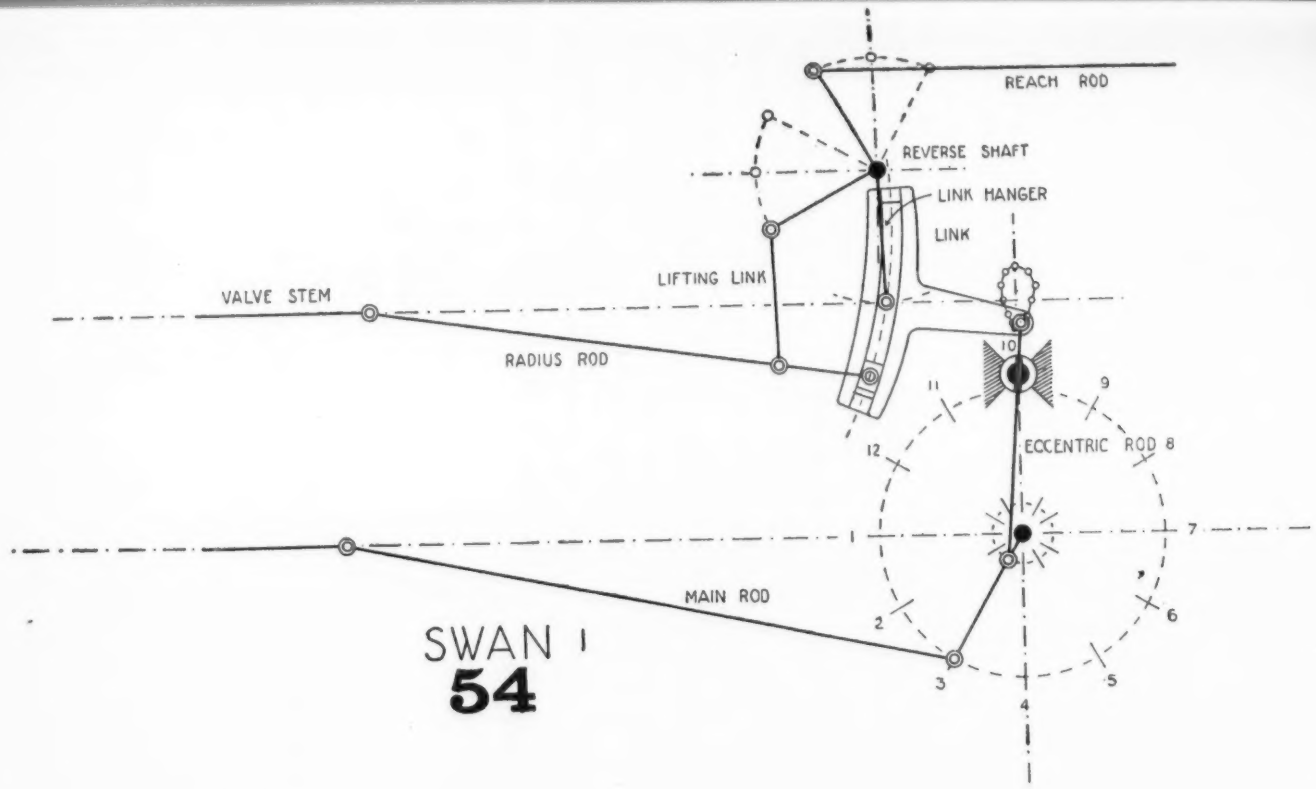
(Dg. 54)

Classification of this gear does not place it under any one of the three principal types. The drive is through an eccentric rod, very much akin to Hackworth's, but this eccentric rod also slides in a rocking guide block whose position is fixed. The upper end of the eccentric rod, by the vertical range of its path, gives the link its port opening motion through the bell-crank, or horizontal arm.

The link, instead of having a fixed center, is supported by a hanger and derives its lap and lead motion from the horizontal movement of the upper end of the eccentric rod.

Reversing and cut-off are arranged for by the radius rod and curved link of Walschaerts' gear; though it could be termed a Gooch link actuated by one eccentric. Both Walschaerts and Gooch motions have two driving points, so that we will have to roughly place this as a combination of Walschaerts, Hackworth and Gooch.

It is safe to say, that with this motion, serious disturbances in correct steam distribution would be suffered through the vertical movement of the driving axle, due to inequalities in the track or variation of load on the driving springs.


REACH ROD
REVERSE SHAFT
LINK HANGER
LINK
LIFTING LINK
VALVE STEM
RADIUS ROD
ECCENTRIC ROD 8
MAIN ROD
1
2
3
4
5
6
7
9
10
11
12

SWAN I

54

SWAN (2)

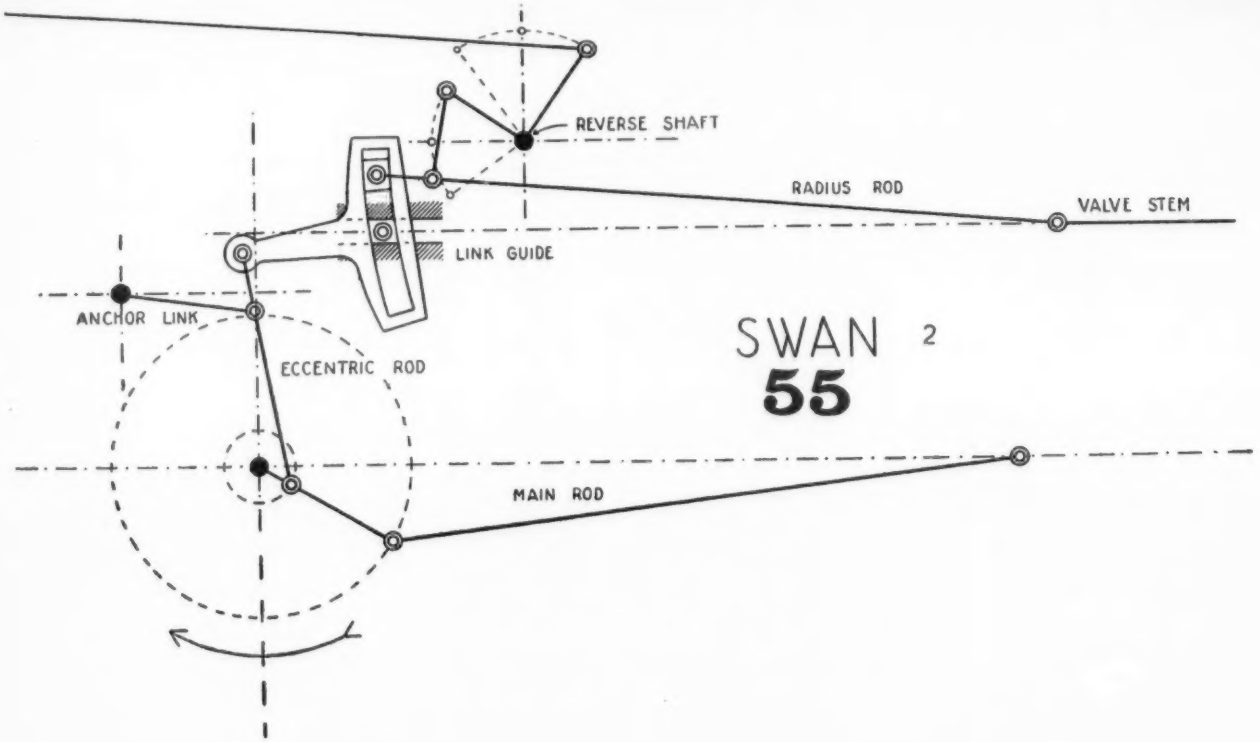
(Dwg. 55)

Another of Swan's gears somewhat similar to the preceding one, the two points of difference being the method of link suspension, and the replacement of the rocking guide-block by an anchor link, the forward end of which provides a fulcrum for the eccentric rod.

Lap and lead movement is provided as in the previously shown Swan gear, though the path of the upper end of the eccentric rod is not quite the same. The link center, instead of being suspended by a hanger, has its center bearing in a small cross-head, which travels horizontally in guides to the extent of the lap and lead movement.

Port opening, as in the first Swan gear, is provided by the swing of the link due to the vertical range of motion of the bell-crank which derives from the upper end of the eccentric rod.

Classification comes under the same head as the Swan gear previously covered.


REVERSE SHAFT
RADIUS ROD
VALVE STEM
LINK GUIDE
ANCHOR LINK
ECCENTRIC ROD
MAIN ROD
SWAN 2
55

SWAN (3)

(Dwg. 56)

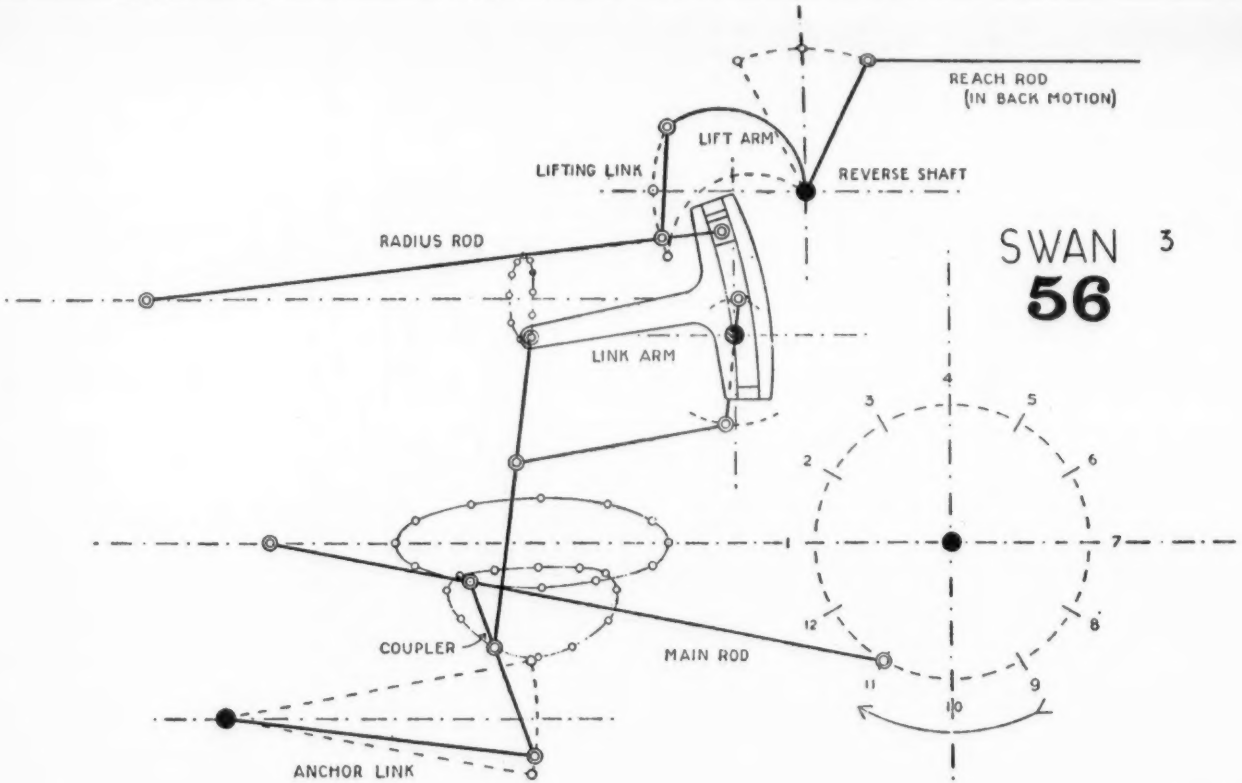
Here again we have a hybrid motion, though rather different from the two Swan gears already described.

In this case the drive originates in the main rod, precisely as with the Joy and Brown gears. The port opening movement of the link comes from an arm on the inner, instead of the outer, side of the link, while the lap and lead movement is given by a short lever which works parallel to the vertical arm, which swings the link through the link arm.

The amount of the lap and lead movement is determined by the ratio between the two ends of this short lever, which is fulcrumed at a fixed point.

With all these Swan gears, when the block is at the center of the link, the valve has only its lap plus lead motion, which is constant, just as is the case with the Hackworth motion; but if the movement of the block is to either side of the link fulcrum the valve receives, in addition, its port opening movement.

These gears were introduced about 1885.


REACH ROD
(IN BACK MOTION)
LIFT ARM
LIFTING LINK
REVERSE SHAFT
RADIUS ROD
LINK ARM
SWAN 3
56
4
3
5
2
6
7
12
8
11
9
10
COUPLER
MAIN ROD
ANCHOR LINK

BRYCE-DOUGLAS (1)

(Dwg. 57)

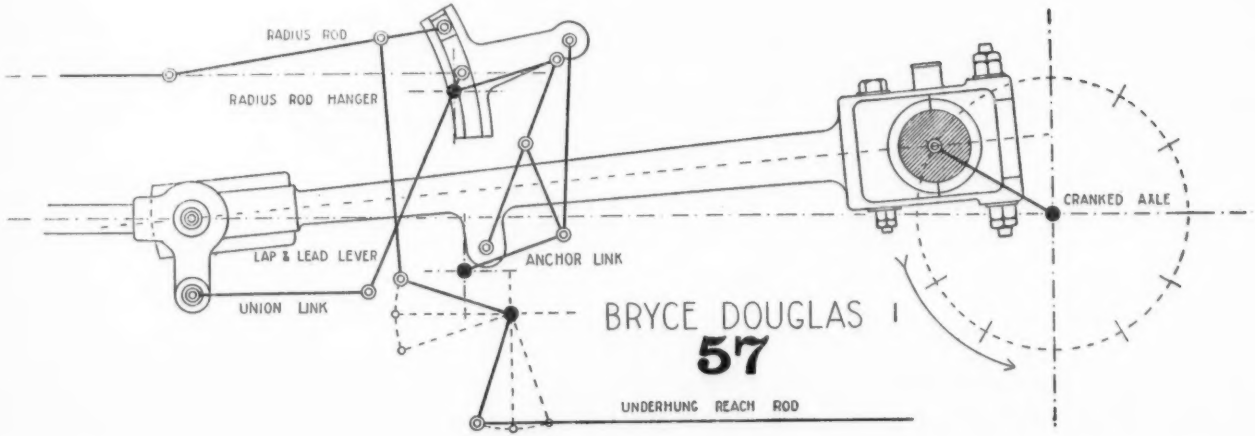
Though it may hardly seem so at first, this rather complicated linkage constitutes a variety of Walschaerts motion. It was invented by Bryce-Douglas, manager of a naval armaments company in England, and was applied to an inside-cylinder 4-2-2 passenger engine on the Caledonian Ry., in 1886, by Dugald Drummond, the road's motive power chief. This locomotive, No. 123, was exhibited at the Paris Exposition of 1889.

Now let us take this gear apart and examine the functions of its various members. First, we have the usual Walschaerts link which, in this case, receives its motion from a point on the main rod between the crosshead and main pin. The series of members transmitting this motion begin with the connection at the short arm projecting down from the main rod. This floating lever is pin jointed to another short rod, the forward end of which pivots on the fulcrum of the lap and lead lever. From the center of the first of these two projects another short arm, which couples to both the anchor link and the reversing-link driving rod.

The result is a compound of the motions of the several rods and levers which was said to have given the link a very even movement.

Lap and lead movement is like that of the conventional Walschaerts, a union link and a lap and lead lever but, instead of the upper end of the latter being coupled to the valve stem, it carries the link itself and moves it bodily back and forth for the necessary lap plus lead distance. So that, though we have neither return crank nor eccentric, we still have, in effect, a Walschaerts gear.

Caledonian engine No. 123 ran for many years, but the Stephenson link had long since replaced its original motion.


RADIUS ROD
RADIUS ROD HANGER
LAP & LEAD LEVER
UNION LINK
ANCHOR LINK
CRANKED AXLE
UNDERHUNG REACH ROD
BRYCE DOUGLAS 1
57

BRYCE-DOUGLAS (2)

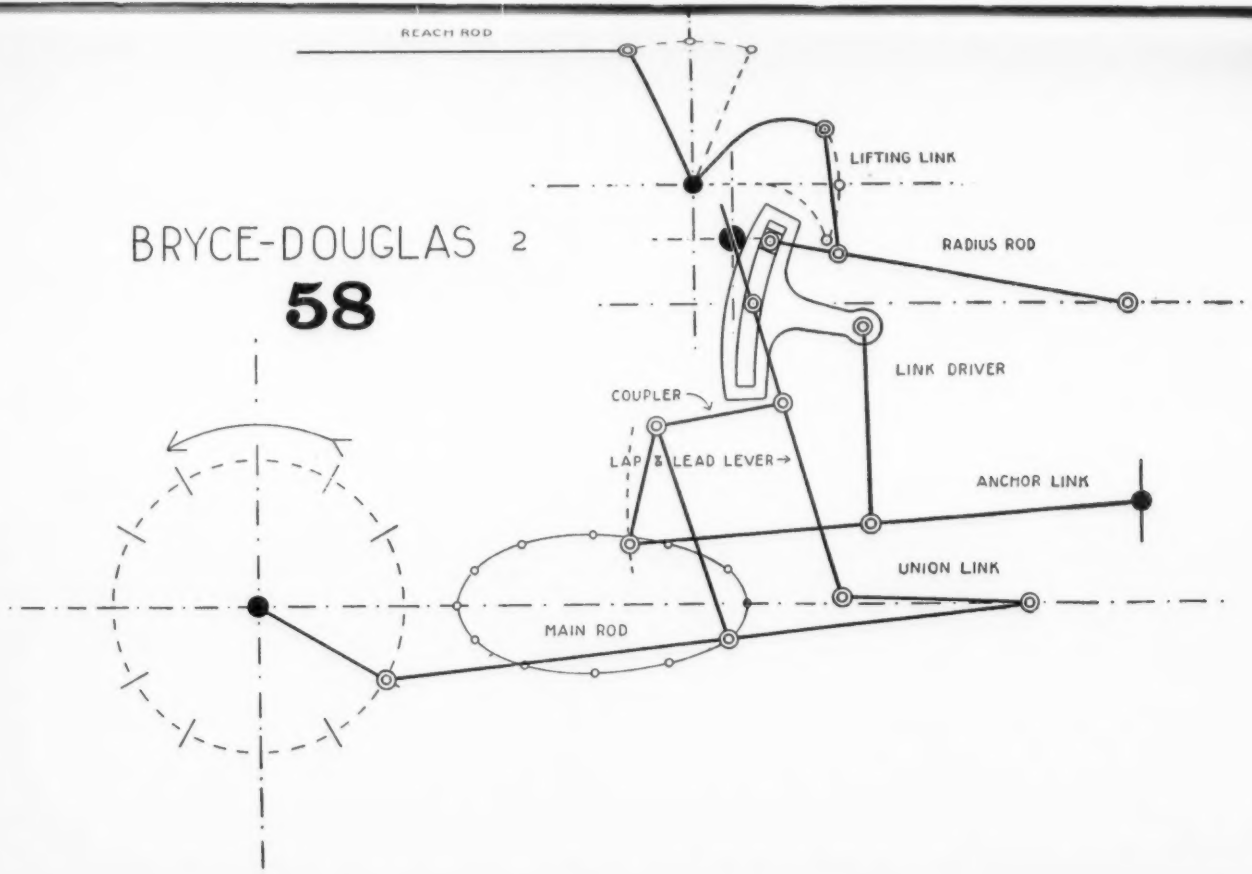
(Dwg. 58)

This arrangement of the Bryce-Douglas valve gear also receives its motion from the main rod and cross-head, but in a somewhat different manner than in the other.

A long achor link receives its swing from a rod pin-jointed to the main rod, and from its mid-point drives the reversing link through a rod to the link-arm. This gives port opening movement to the link.

Lap and lead movement is provided for partly by a union link, and a lap and lead lever consisting of an "air pump" lever, so called. Part of the lap and lead lever motion comes also from the combination of levers receiving their impulse from the main rod connection.

When one considers the complications in this, as compared with the conventional Walschaerts gear, it is not hard to see why it never brought fame or fortune to its inventor.


REACH ROD
LIFTING LINK
BRYCE-DOUGLAS 2
58
RADIUS ROD
LINK DRIVER
COUPLER
LAP & LEAD LEVER
ANCHOR LINK
UNION LINK
MAIN ROD

PAYTON

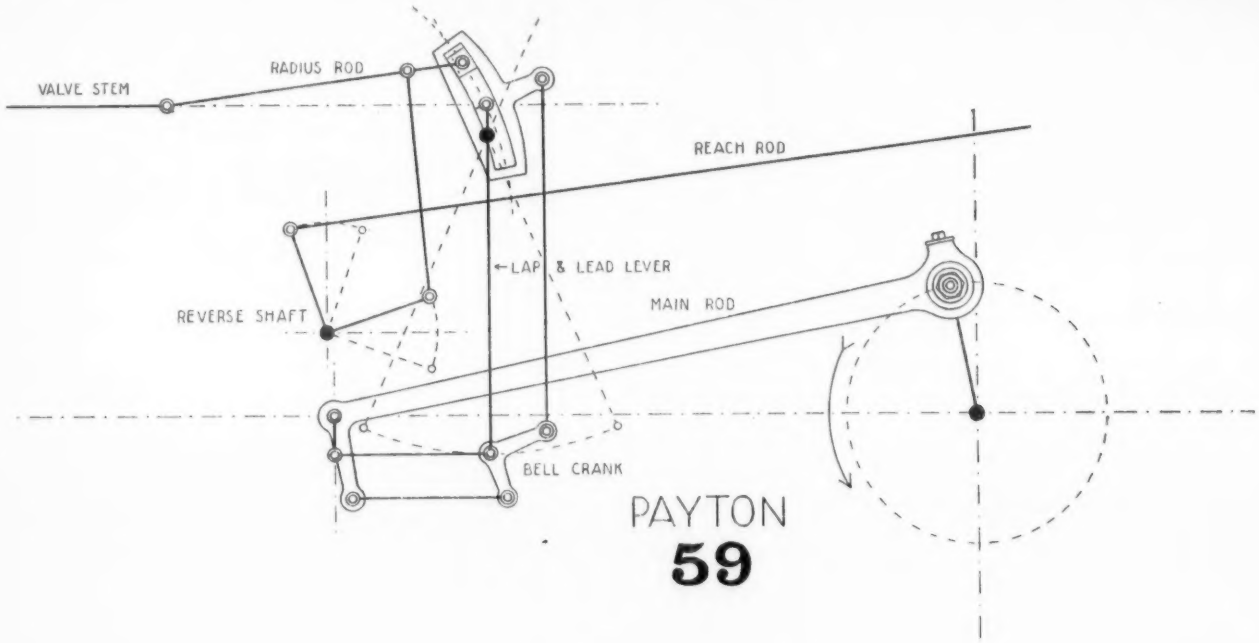
(Dwg. 59)

This version of Walschaerts motion, brought out in 1888, is a somewhat roundabout way of attaining the same ends. A constant lead movement is taken from the cross-head through a union link and lap and lead lever whose upper end carries the link. The link center being above the fulcrum indicates the use of an outside admission valve.

Port opening movement comes from a linkage starting at the foot of the arm projecting down from the front end of the main rod. It continues through a bell-crank, which pivots at the pin connection of the union link and lap and lead lever, and from the bell-crank continues to the outer end of the link arm.

The foot of the main rod arm travels in almost a straight line, so that there is practically no error to be compensated.

This may be a theoretically good motion, but we would hardly care to be responsible for keeping a large number of engines, so fitted, in good working order.


VALVE STEM
RADIUS ROD
REACH ROD
LAP & LEAD LEVER
REVERSE SHAFT
MAIN ROD
BELL CRANK
PAYTON
59

FIDLER

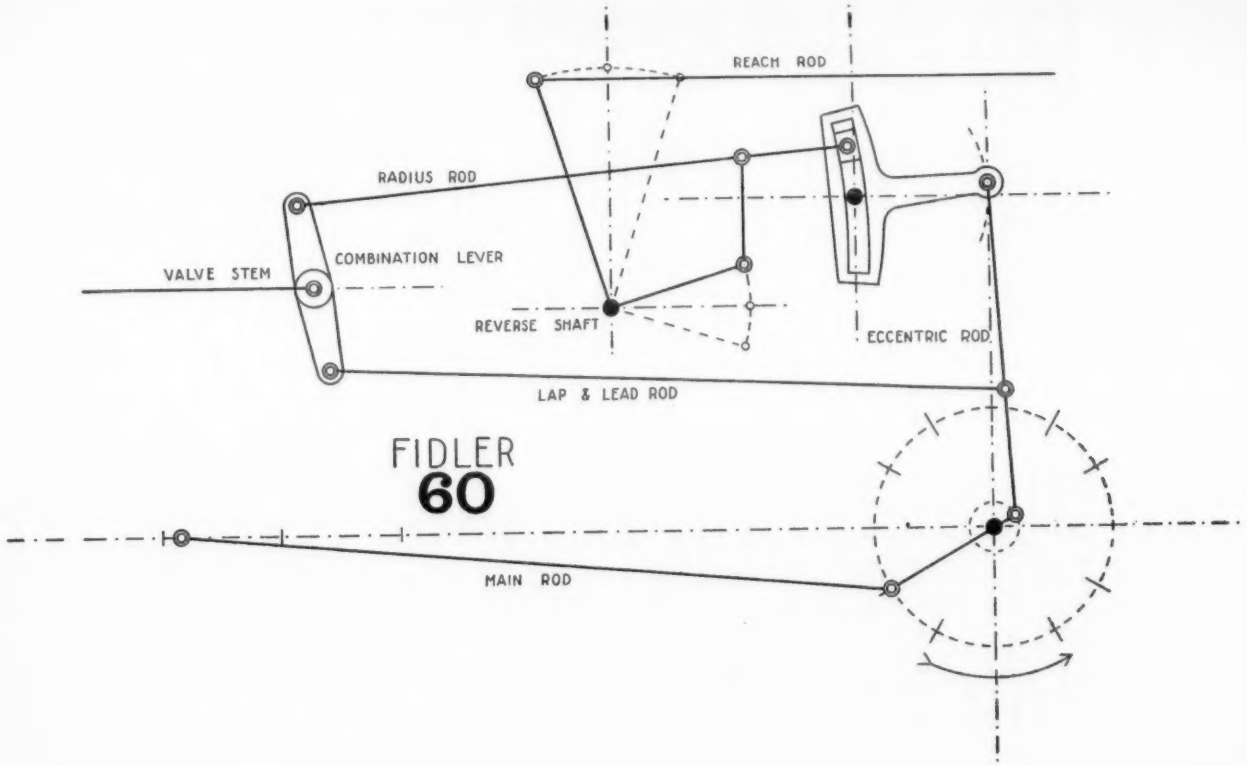
(Dwg. 60)

An English variety of Walschaerts motion by T. Claxton Fidler, this comes nearer to simplifying it than many of the so-called improved gears.

Though having but one driving point, the return crank pin, or eccentric, whose center is opposite that of the main pin, it gives both port opening and lap and lead movements in a very simple manner.

The eccentric rod drives the reversing link through the link arm for the port opening movement, while the lap and lead movement is obtained in a manner quite different from that usually seen.

In this case, the long lap and lead rod, which might better be called a union link, drives the short combination, or lap and lead, lever, to give the valve its typical Walschaerts movement. This combination lever is necessarily short because of the small range of motion afforded by the point at which it is pin-jointed to the eccentric rod. The result, though, is the same as if the lap and lead lever were the usual length and were actuated from the cross-head.


REACH ROD
RADIUS ROD
VALVE STEM
COMBINATION LEVER
REVERSE SHAFT
ECCENTRIC ROD
LAP & LEAD ROD
FIDLER
60
MAIN ROD

ENGELMANN

(Dwg. 61)

In designing his various valve motions Englemann's aim appears to have been the elimination of sliding surfaces, such as the link and block. In arriving at this end, most of his gears became quite complicated, but this odd and highly ingenious mechanism shows how he attained reversion and cut-off with very few parts, though at the cost of two quite serious defects.

The principle involved in reversing is in the change of position of the fulcrum point of the rocker and, in consequence, that of the driving point. This change, which moves the lift arm 55 degrees to either side of the neutral, or mid-gear, position, moves the driving point (the end of the eccentric arm) to the extent of 60 degrees. This difference of 5 degrees is due to the lift arm being longer than the eccentric arm.

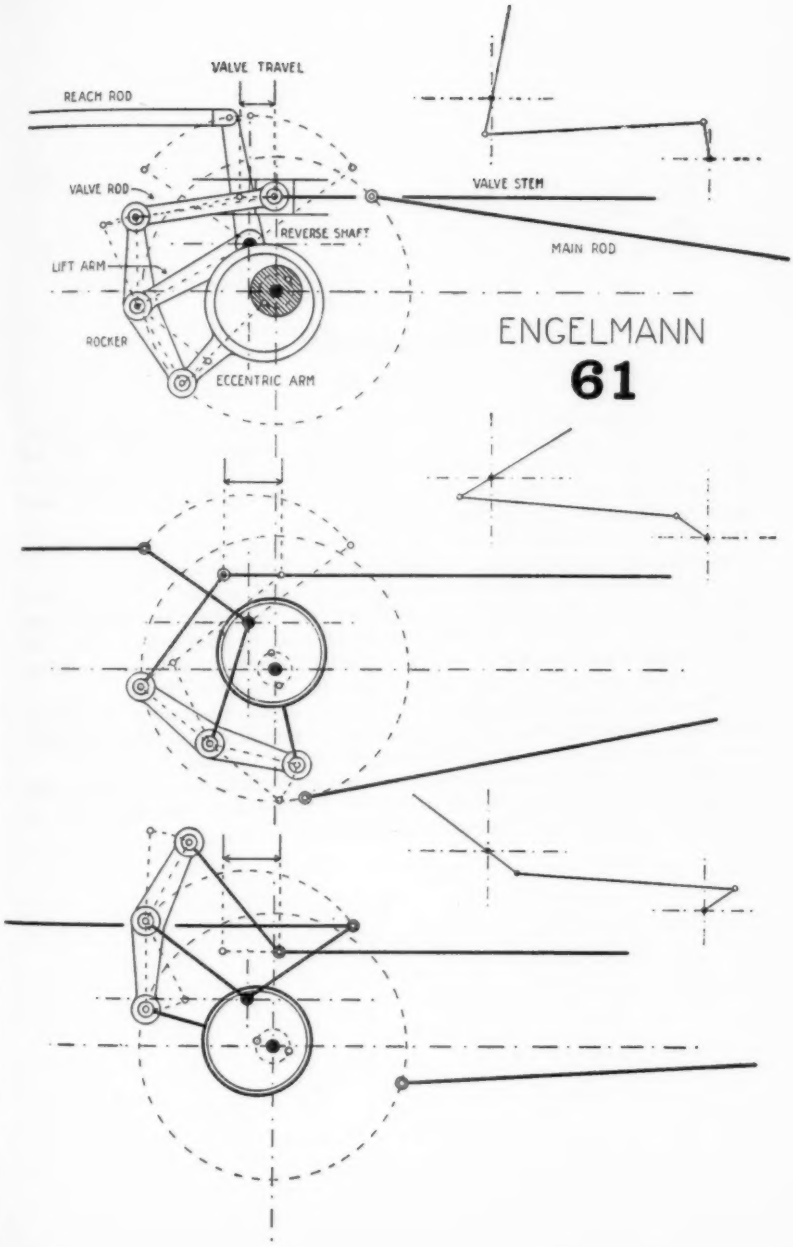
When the eccentric arm and strap have been moved to either side 60 degrees, a forward or back motion is attained, with an angular advance of 30 degrees.

The three positions of the reach rod and reverse arm show plainly the change involved. While the eccentric throw, and consequently that of the upper end of the rocker, remain practically constant, the valve travel is increased or diminished as the lift arm is moved away from or toward the intermediate position. This is due to the change in the angular position of the valve rod in relation to the path of the slide valve crosshead which is horizontal. In mid-gear the angle is little or nothing; in full gear (late cut-off) the valve rod presents a very considerable angle to the valve crosshead. It is this difference that makes the valve travel variable.

In this arrangement, which is for outside admission, the main pin is on the opposite side of the axle from the eccentric. The diagrams show the main pin and rod in three different positions. The first shows the reverse lever just ahead of the center notch, with valve travel at or near minimum. The other two show the reverse lever in full forward and back motions.

The two serious drawbacks are, the extreme throw of the reverse lever, and the very high angles of the valve rod when at anything but the closest cut-offs. The latter tends to cause serious thrusts on the valve crosshead guides, and heavy strains on the other working parts. And hooking up an engine with this motion, if under a load, would be a hazardous undertaking. In studying these three diagrams it will be seen that, in both forward and back gear, valve travels strictly correspond with each other, and should do so at points of lesser cut-off.

This motion appeared in the early 1860s, but the writer is unaware of its ever having been used in the locomotive field.


VALVE TRAVEL
REACH ROD
VALVE ROD
REVERSE SHAFT
LIFT ARM
ROCKER
ECCENTRIC ARM
VALVE STEM
MAIN ROD
ENGELMANN
61

ENGLEMANN

(Dwg. 62)

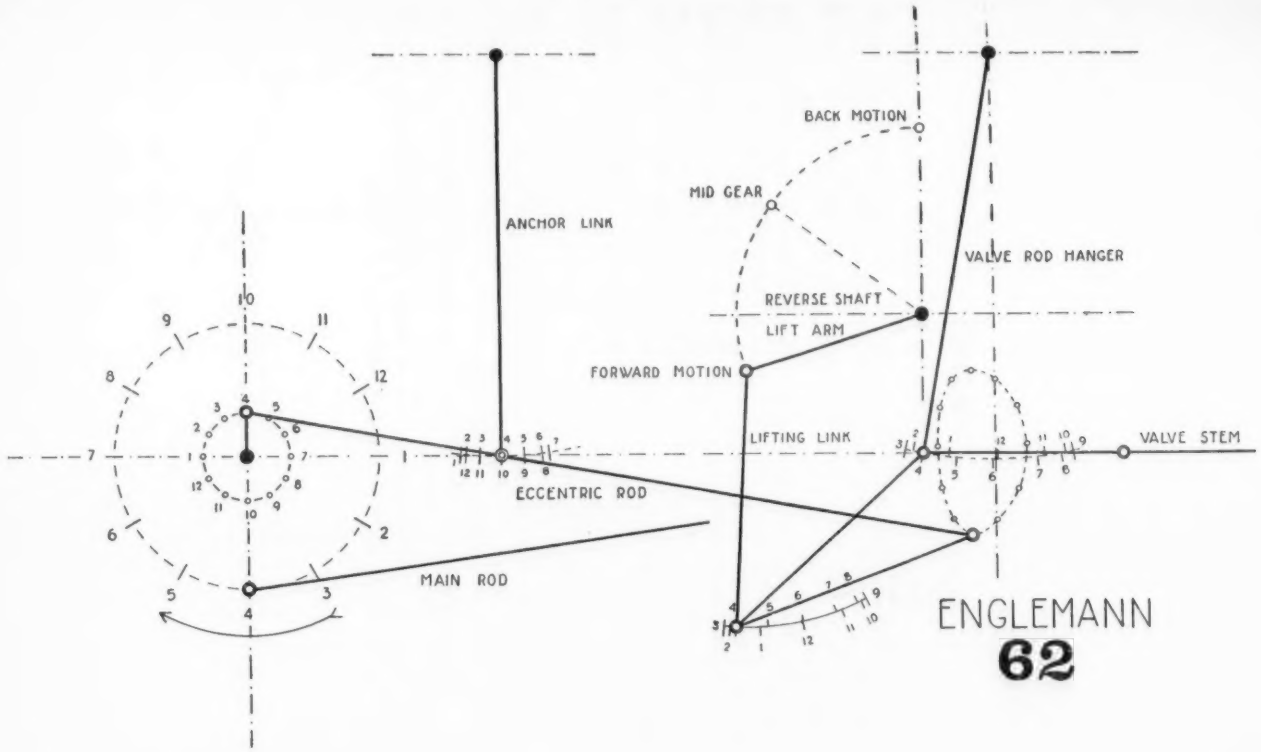
The Englemann gears, which constituted several distinct types, were brought out about the same time as Hackworth's. They were not based on any existing motions, such as Stephenson's, Walschaerts' or Hackworth's, and have never been practically applicable in the hard usage to which the locomotive is usually put.

The example here shown illustrates an approach totally different from ordinary methods, and is included only for its novelty.

The drive is through a single eccentric and its rod. The latter is fulcrumed on an anchor link at a point less than half its length from the eccentric, resulting in very severe strains at this point. The lift arm travels through an arc of more than 90 degrees, and the resulting valve travel is considerably more than the eccentric throw.

Two long arms, the anchor link and the valve rod hanger are swung from high above the frame and, aside from being a complicated arrangement, the design is far from being mechanically feasible.

Two more gears, one driven from the main rod, and the other from a single eccentric, were worked out by Englemann, but both are too complicated to call for further mention here.


BACK MOTION
MID GEAR
ANCHOR LINK
VALVE ROD HANGER
REVERSE SHAFT
LIFT ARM
FORWARD MOTION
LIFTING LINK
VALVE STEM
ECCENTRIC ROD
MAIN ROD
ENGLEMANN
62

MORTON

(Dwg. 64)

Alexander Morton's gear, which was in use mainly on marine engines, is literally in a class by itself. In addition to being highly corrected, it fails to be classified under any known system or type of valve motion.

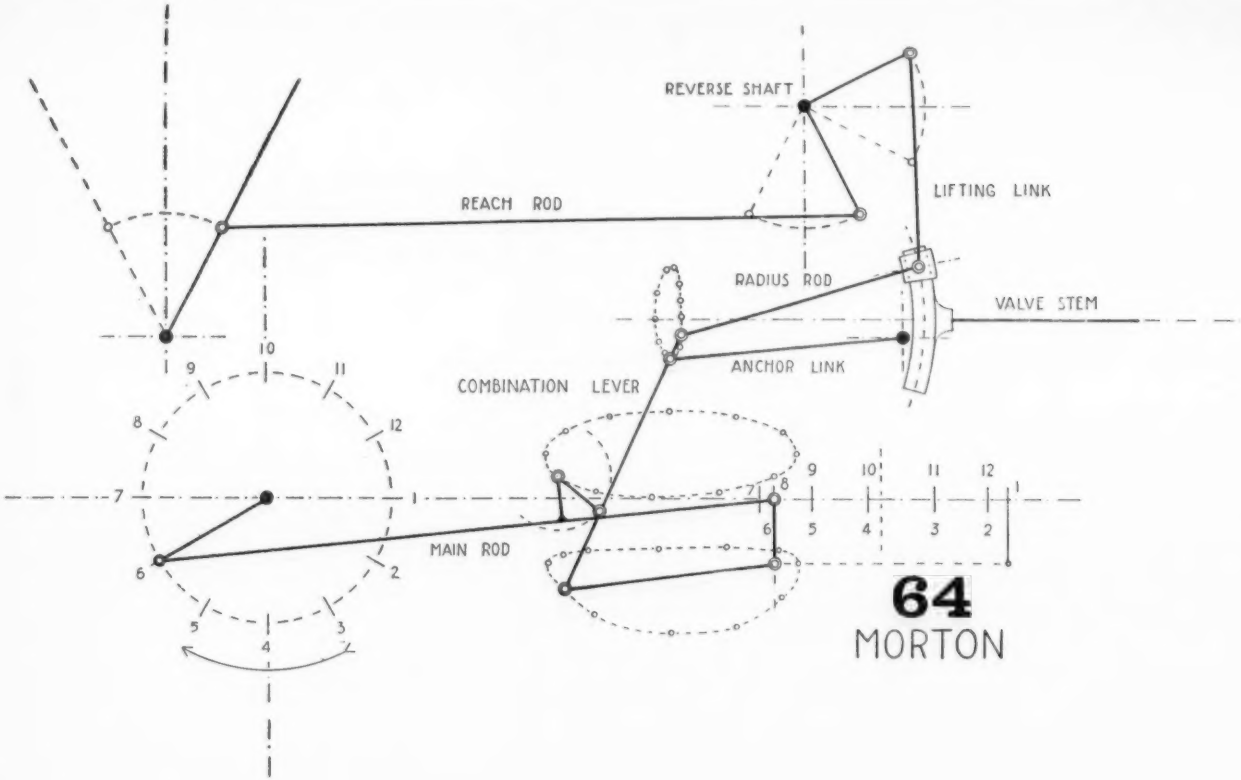
The drive is from two points, a short upward arm on the main rod, similar to those of Joy and Brown, and a downward crosshead arm, such as in Walschaerts'. The combination lever acts very much as in the Walschaerts gears, but takes an entirely different path at the backend.

The link, instead of being supported on a trunnion, becomes part of the valve stem, to which it is rigidly fastened and, instead of the link moving the radius rod, the radius rod moves the link.

Reversal is accomplished by dropping the link block to the opposite end of the link and, as with other gears, when the block is in mid-position, only a lap and lead movement is given to the valve.

In the Walschaerts motion the combination lever gives the valve its lap plus lead movement, while the eccentric and its rod take care of the port opening. In Morton's the valve travel is a composite effect of the movement of both connections.

The laying out of this motion is too long and involved a problem to undertake here, but anyone with the training necessary to lay out valve gears will find it interesting to study Morton's effort in arriving at the very highly corrected gear he invented in 1882.


REVERSE SHAFT
REACH ROD
LIFTING LINK
RADIUS ROD
VALVE STEM
ANCHOR LINK
COMBINATION LEVER
MAIN ROD
64
MORTON

ARROL & PRINGLE

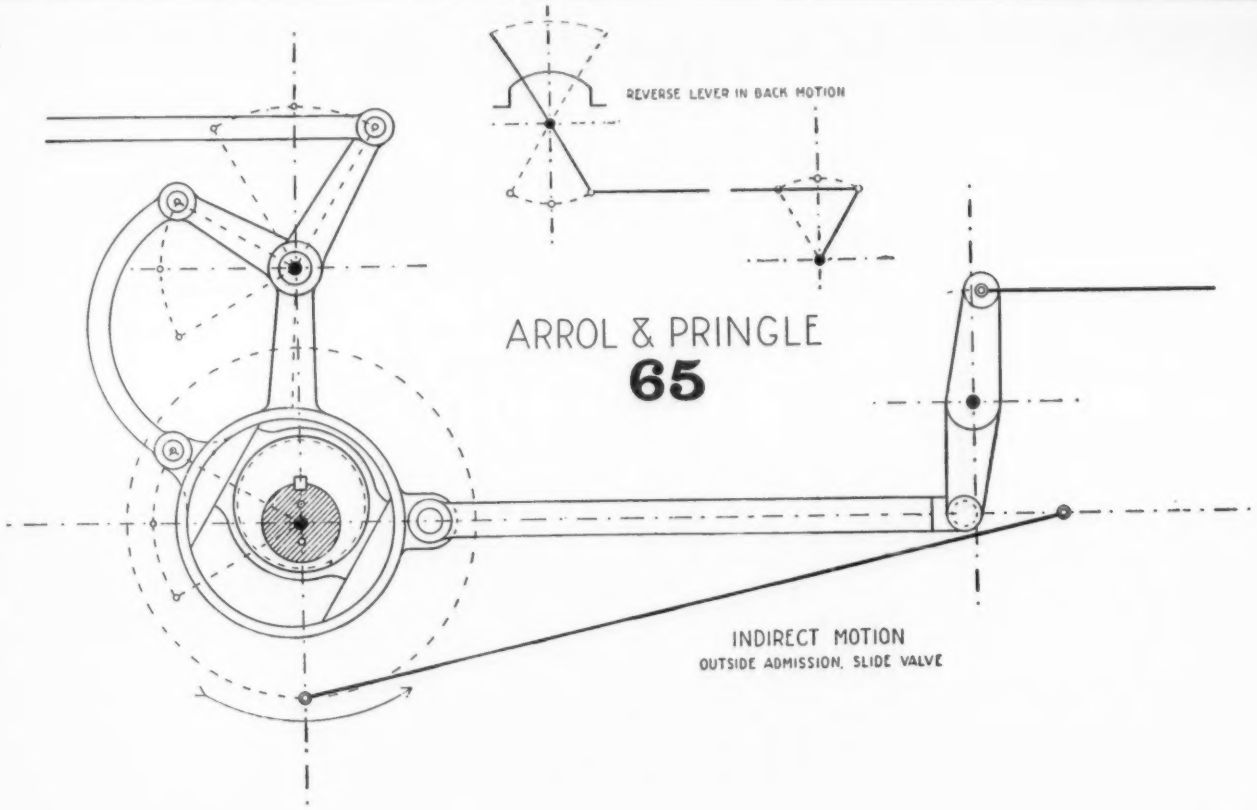
Indirect Motion

(Dwg. 65)

This shows the Arrol & Pringle gear as applied to an outside-admission, indirect-motion valve.

The reverse lever is placed in back motion and the main pin is at the bottom quarter, showing the eccentric at the top position, and the eccentric strap guides in full angular position for back motion.

Where the reach rod connection is above the lift, or reverse, shaft, the reverse lever must be fulcrumed above its reach rod connection, as shown by the half-scale sketch of the reversing mechanism.


REVERSE LEVER IN BACK MOTION
ARROL & PRINGLE
65
INDIRECT MOTION
OUTSIDE ADMISSION, SLIDE VALVE

ARROL & PRINGLE

(Dwg. 97)

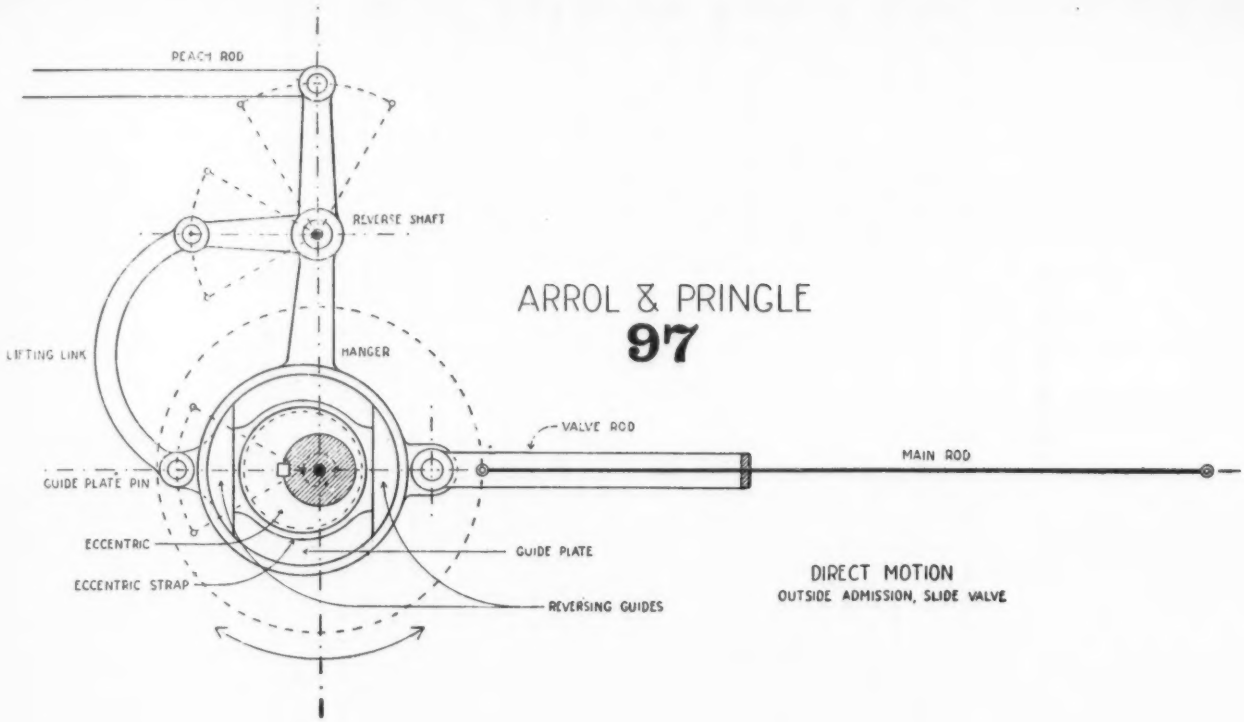
A single eccentric motion in which the eccentric and its strap are encased in an outer ring, the upper arm of which is fulcrumed on the reverse shaft, and which has a pin connection to the valve rod.

The eccentric strap has two parallel sides to the front and rear. These bear on two segmental guides which are kept in alignment by being bolted to a circular plate.

The lower end of the curved hanger has a pin connection with a short arm which is part of the rear guide. This arm extends through a slot in the outer ring and moves through an arc of about 30 degrees to either side of the intermediate position, turning the eccentric strap guides to the proper angle for forward or back motion according to the position of the reverse lever.

As the eccentric rotates, the whole ring moves back and forth, swinging from the reverse shaft, thus giving the necessary valve travel. With the reverse lever at the center of the quadrant the eccentric strap guides are in perpendicular position, the eccentric strap moving up and down to the extent of the throw of the eccentric, thus swinging the ring and its valve connection to the same extent in a horizontal direction. When on center, lap and lead movement are given. Lead is constant.

This motion has the drawback that, when the engine is working at a late cut-off, as would happen with a heavy load, the eccentric strap guides are at greater angularity, and there is, in consequence greater pressure and friction at these points.



ARROL & PRINGLE

97

DIRECT MOTION

OUTSIDE ADMISSION, SLIDE VALVE

STEWART-FINK

(Dwg. 66)

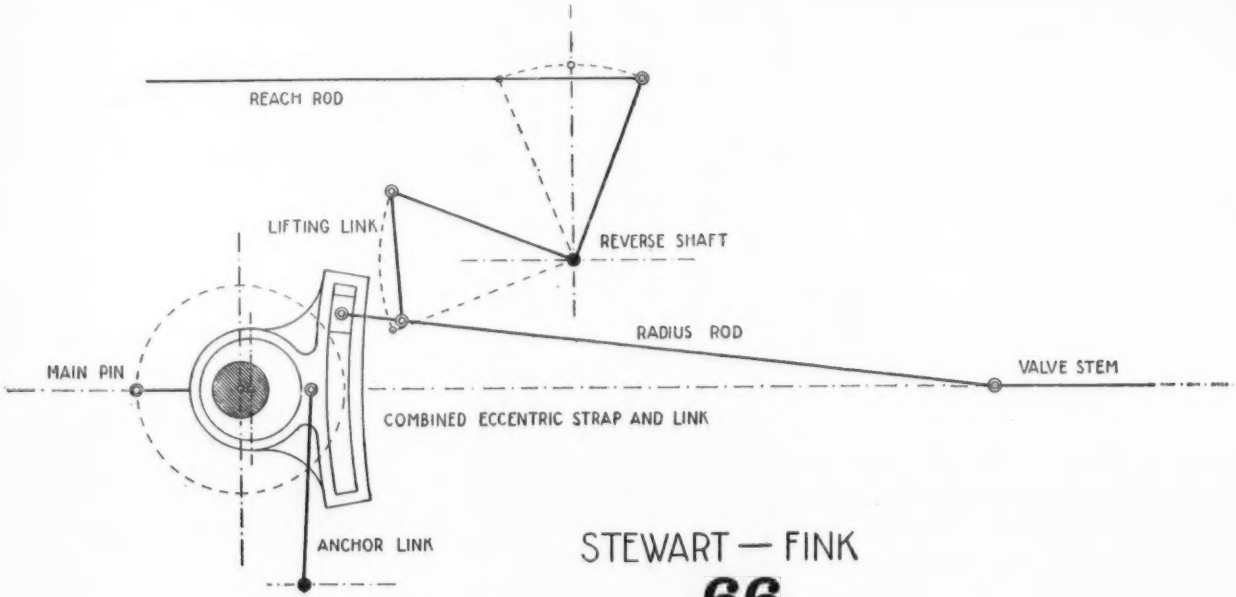
The Stewart-Fink link is a combination of a link with the eccentric-strap of a single eccentric, in such a way that the direction of the motion of the engine or the travel of the valve may be controlled in the same manner as with the double eccentric motions. More particularly it might be termed a Gooch single eccentric motion.

With this link the eccentric center is directly opposite the crank-pin, the link being cast solid with the forward half of the strap. As the eccentric revolves, the top of the anchor link swings in an arc, the chord of which is equal in length to the throw of the eccentric. The up-and-down motion of the eccentric gives additional motion to the upper and lower ends of the link. The combined motion closely approximates that of the Gooch double link motion, the lead being constant.

While this very simple valve motion has never seen much use as a reversing gear, it did serve as an automatic cut-off gear for the once popular Porter-Allen stationary engine, in which the eccentric and main shaft were in one forging, and the eccentric center on the same side of the shaft as the crank-pin. In the Porter-Allen stationary engine only the top half of the link is used, the bottom being cut away. This leaves the top of the anchor link connected to the bottom of the half link as shown in the smaller sketch. The link block is raised and lowered in the link by a rod from the ball governor, thereby shortening or lengthening the period of admission. Exhaust valves are driven from a fixed point on the link. Naturally this exhaust connection is practicable only in case the engine runs in one direction.

In the reversing variety of this gear it should be noted that the anchor-link footing should be supported from the axle to avoid irregularities in steam distribution due to the action of springs.

This gear was arrived at independently by Stewart, of Sharp, Stewart & Co., locomotive builders of Manchester, England, in 1857; and by Pius Fink, of Germany, the same year.



STEWART — FINK

66

THOM

(Dwg. 67)

A very similar, though much simpler, gear than the Payton was invented about the same time by John Thom.

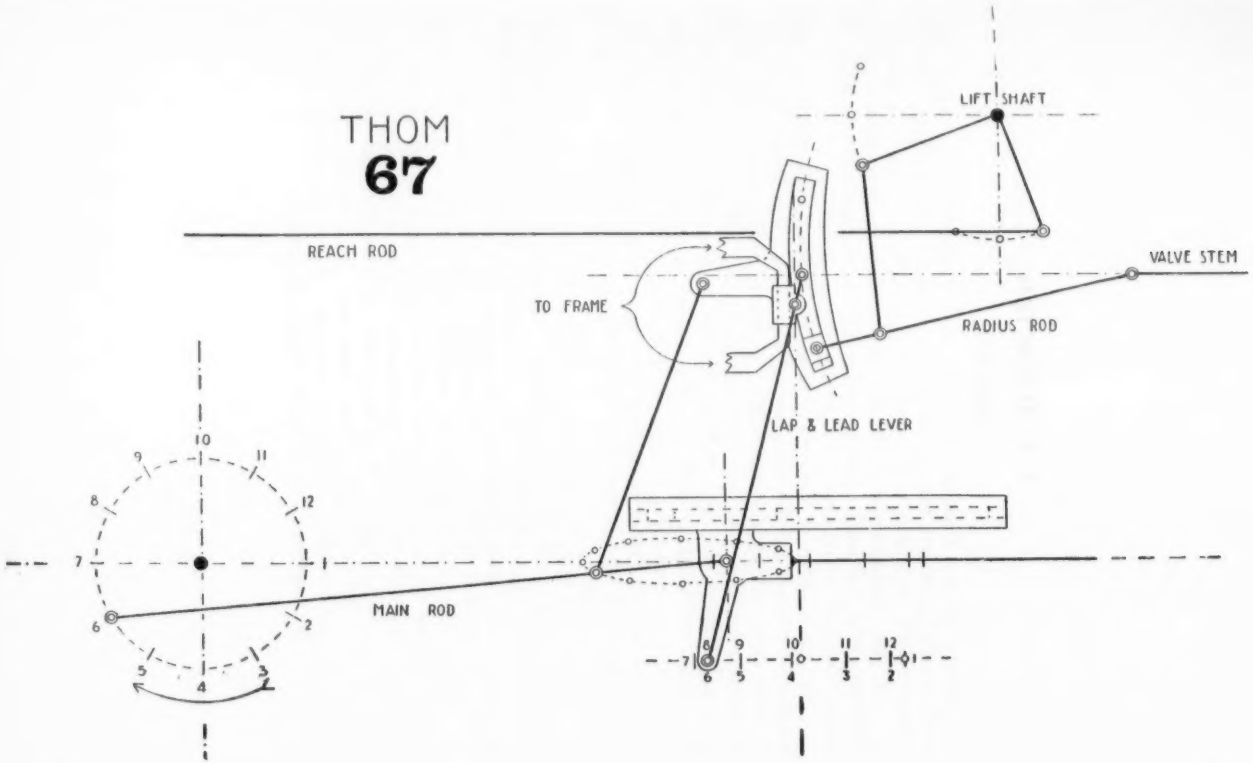
The foot of the lap and lead lever is connected directly to the cross-head arm, the upper end carrying the link, and thus providing constant lead.

Port opening movement of the link is obtained through the drive from the main rod just back of the cross-head. This swings the end of the link arm up and down and so oscillates the link.

It will be noticed that the lap and lead lever is fulcrumed on a block which travels in a short vertical path. The fact of the lap and lead lever travelling in a straight line at its lower end gives the link just enough vertical movement to correct the error which would otherwise be caused by the swing of the link driving rod.

THOM

67


LIFT SHAFT
REACH ROD
VALVE STEM
TO FRAME
RADIUS ROD
LAP & LEAD LEVER
MAIN ROD

T. F. REDINGTON

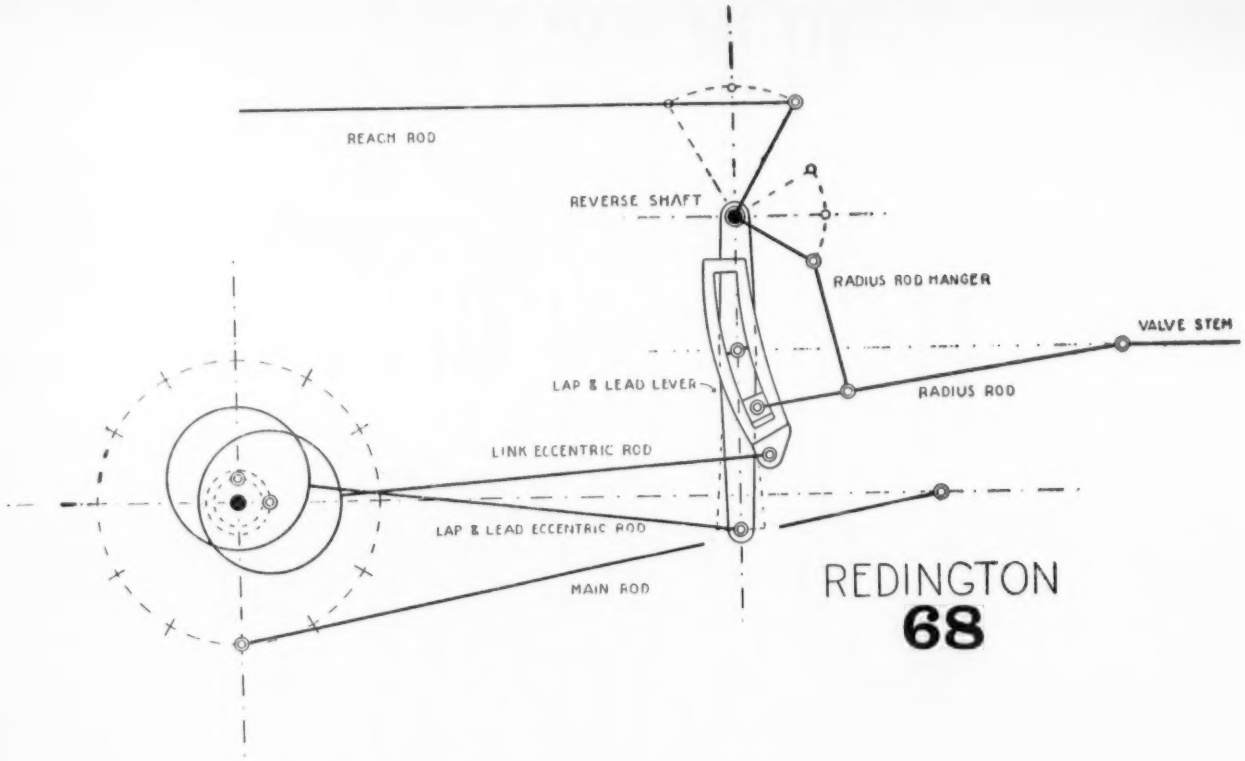
(Dwg. 68)

This gear, an English invention, was designed to do away with rockers on locomotives having steam chests above the cylinders. Though operated from two eccentrics on the driving axle, it is really a modification of the Walschaerts principle, the reversing arrangement being identical, and the lead constant. The lap and lead lever is given its motion through a rod from the shorter throw eccentric.

The main point of departure from the Walschaerts design is that, instead of connecting the back end of the valve stem to the upper end of a lap and lead lever, it is directly connected to the radius rod. Lead is derived by means of the lap and lead lever which moves the link back and forth to the extent of the lap and lead movement of the valve. The motion of this lever is through a rod from the eccentric, whose center is 180 degrees from the main pin. The throw of this eccentric, together with the relative distances between the link fulcrum and the two ends of the lap and lead lever, determine the amount of lead. Cut-off is altered as usual.

When, as is the case with many of the older English locomotives, the steam chests are between the cylinders, the link-driving eccentric may be connected to the top of the link, the eccentric being 90 degrees ahead, instead of 90 degrees following, the main pin; also the center of the motion is dropped to the level of the center line of the cylinders.

While this motion might be worked from double eccentric cranks located on the main pin, it would not prove as simple a gear as the conventional Walschaerts. It is questionable as to whether it would be much of an improvement over the usual Stephenson link, except that through its application the steam chest may be brought closer to the saddle, and the rocker, usually a necessity where the steam chest or valve chamber is above the cylinder, dispensed with.


REACH ROD
REVERSE SHAFT
RADIUS ROD HANGER
VALVE STEM
LAP & LEAD LEVER
RADIUS ROD
LINK ECCENTRIC ROD
LAP & LEAD ECCENTRIC ROD
MAIN ROD
REDINGTON
68

REDINGTON

Single Eccentric

(Dwg. 69)

Another gear by T. F. Redington; designed for inside cylinders. The use of only one eccentric for each side of the cranked axle allows some needed space for the thickening and strengthening of the crank webs.

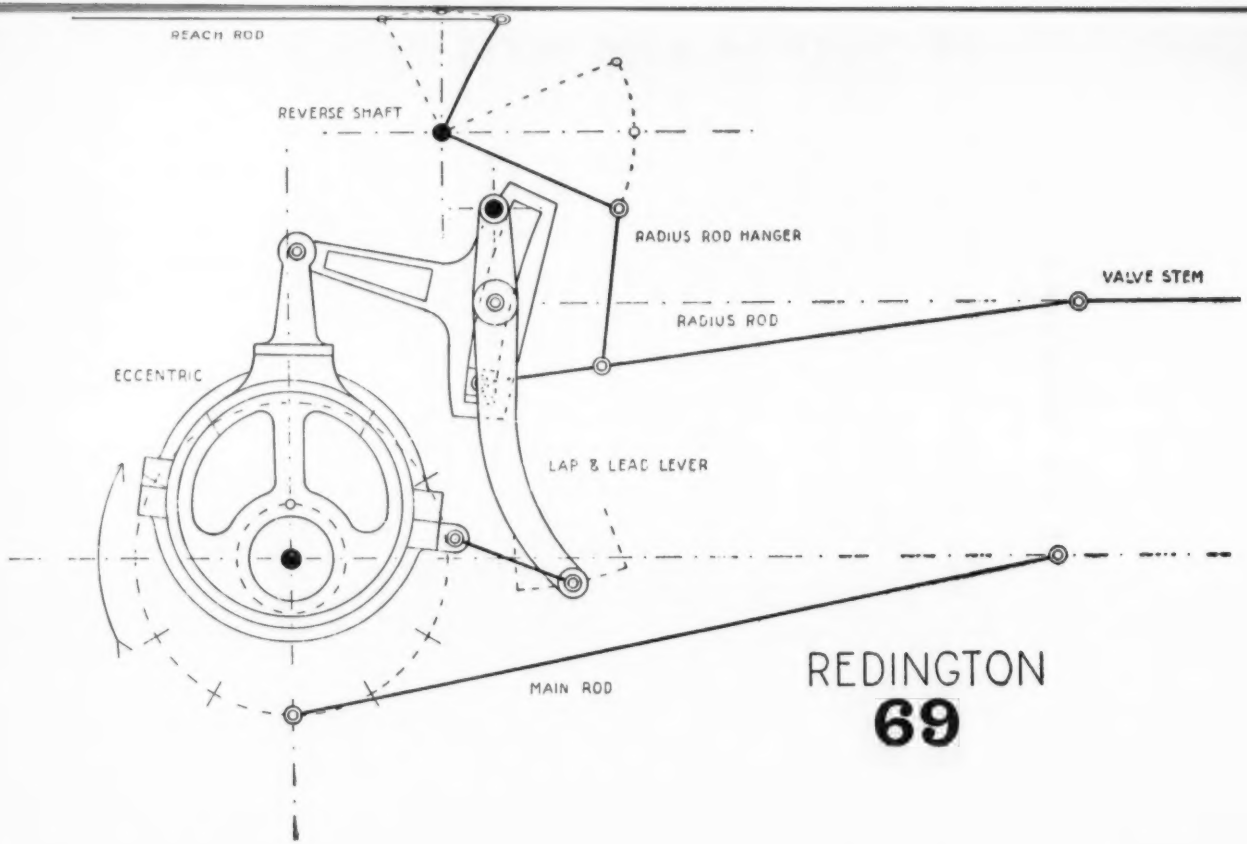
As will be seen, the eccentric center is 180 degrees from the main pin on its own side; and the lap and lead lever gets its swinging motion by means of a short eccentric rod connecting the forward side of the strap.

As in the two-eccentric Redington gear, the center of the valve-actuating link is moved the correct distance for lap and lead. This expansion link carries an arm which receives its motion from the short eccentric rod at the top of the eccentric strap, and it is oscillated about its center. This center is a short distance below the fulcrum of the lap and lead lever. Thus the valve gets its necessary travel.

Reversal and cut-off are by the same methods as in Walschaerts and Gooch motions, through hanger and radius rod.

It would appear that steam distribution would be disturbed to a considerable extent through the vertical movement of the driving axle relative to the engine frame.

As to classification, this is a constant lead motion and may be considered as a modification of either Walschaerts or Gooch motions.



REDINGTON

69

P. L. M. (WALSCHARTS)

(Dwg. 91)

It has been said that the Frenchman delights in an intricate mechanism. A glance at this P. L. M. valve motion and one might well believe it.

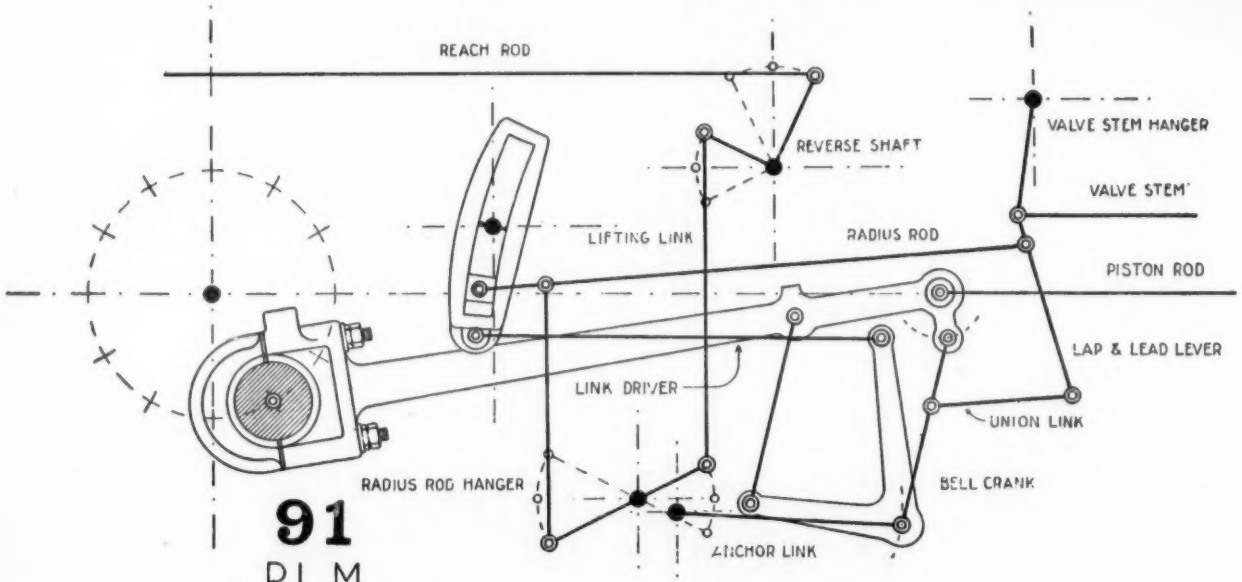
In 1892, the Paris, Lyons & Mediterranean Ry. built a class of eight-wheel (4-4-0), four-cylinder balanced compounds, on which the drive of the outside H. P. cylinders was to the rear drivers. The H. P. valves were driven by Walschaerts gear; while the inside L. P. cylinders drove on the forward axle, from which Gooch motion actuated the valves.

This Gooch motion was later replaced by an "improved" Walschaerts gear, to better steam distribution and do away with the four eccentrics. The link drive is from the main rod not far back of the cross-head connection, and through a bell-crank and driving rods. This bell-crank is pivoted at the forward end of an anchor link and a connection to the short projecting arm at the front end of the main rod. About midway of this latter connection a union link drives the usual lap and lead lever.

As the low-pressure cylinders were between the frames, the steam chests were placed outside, which entailed the use of a rocker arm connection to the valve-stems; and to complete the ensemble, a very ingenious and highly complicated steam reverse gear operated both sets of motion, giving the correct cut-off for both the high and low pressure cylinders, at any position of the reverse lever.

While this motion gave wonderful indicator cards, it was not long before the change was made, back to the old Gooch gear. The steam reverse gear also went the way of the new inside motion, and was replaced by a simpler device, which gave the low pressure cylinders a fixed cut-off.

As the reader may guess, the company found that the cost of maintaining the new valve-motion was out of all proportion to the savings effected by its use.



91

P.L.M.

WALSCHAERTS

BAGULEY

(Dwg. 92)

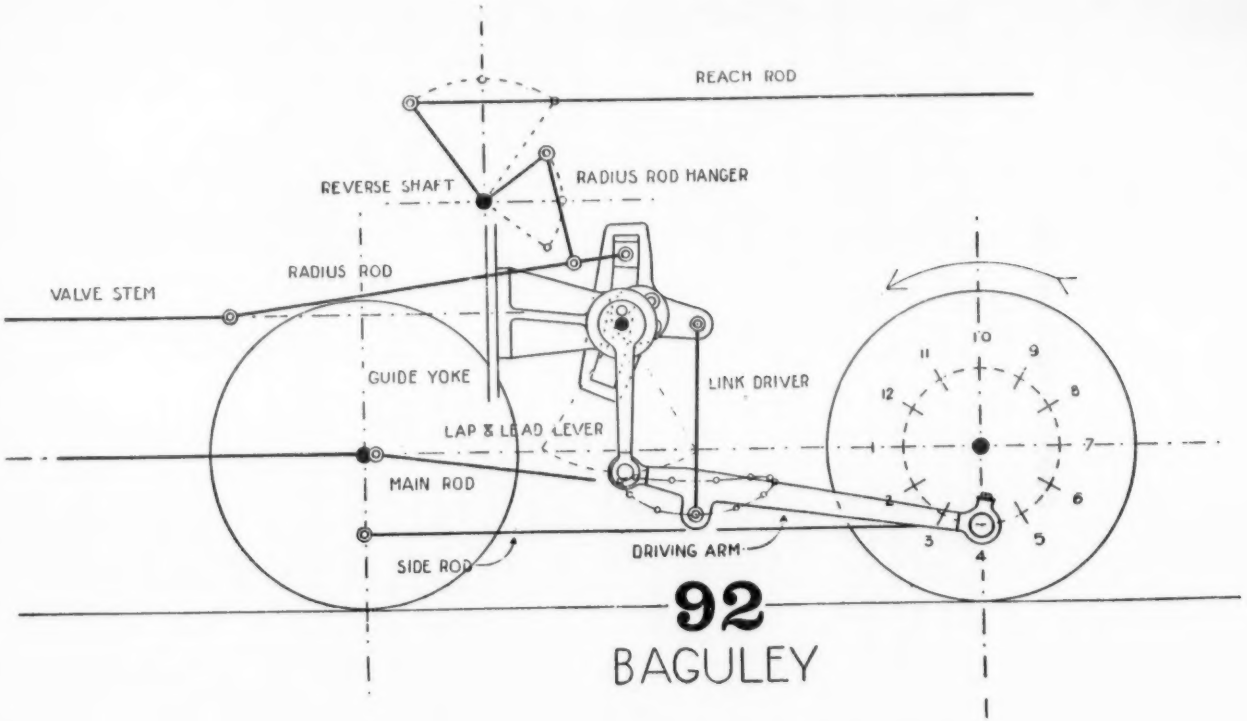
This gear has given very satisfactory service on a number of small locomotives used in plantation and industrial service. It was invented by Major E. J. Baguley, of the Baguley Works, Burton-on-Trent. England. The firm builds locomotives up to 35 tons weight, with cylinders to 15″ diameter.

The example shown is from a design for a 30″ gauge, 0-4-2 engine with slide valves and 6″x9″ cylinders, and 20″ drivers; and in this case the driving rod connection at the main pin is between the main- and side-rods. As the gear works in a vertical plane, the steam chest may be placed fairly close to the saddle, though there is no reason why the drive rod cannot be placed at the outer end of the main pin. Illustration shows main rod cut away.

This gear may be classified as a modification of Walschaerts', the lap and lead movement acting directly on the link through the pin just above the center of the motion bracket. The location of the lap and lead lever does not alter its function.

The link driver takes its motion from the projection at the lower side of the driving arm, or rod. This offset is required to correct an error in the movement of the link.

The arc described by the lower end of the lap and lead lever is the same as that derived from the crosshead (the usual method with Walschaerts gear), while the path of the lower end of the link driver is shown as a flattened ellipse. Valve travel and points can be worked out from this closed curve by means of paper templates.


REACH ROD
REVERSE SHAFT
RADIUS ROD HANGER
RADIUS ROD
VALVE STEM
GUIDE YOKE
LINK DRIVER
LAP & LEAD LEVER
MAIN ROD
SIDE ROD
DRIVING ARM
12
11
10
9
8
7
6
5
4
3
2
1

92

BAGULEY

DODDS. WEDGE MOTION

(Dwg. 98)

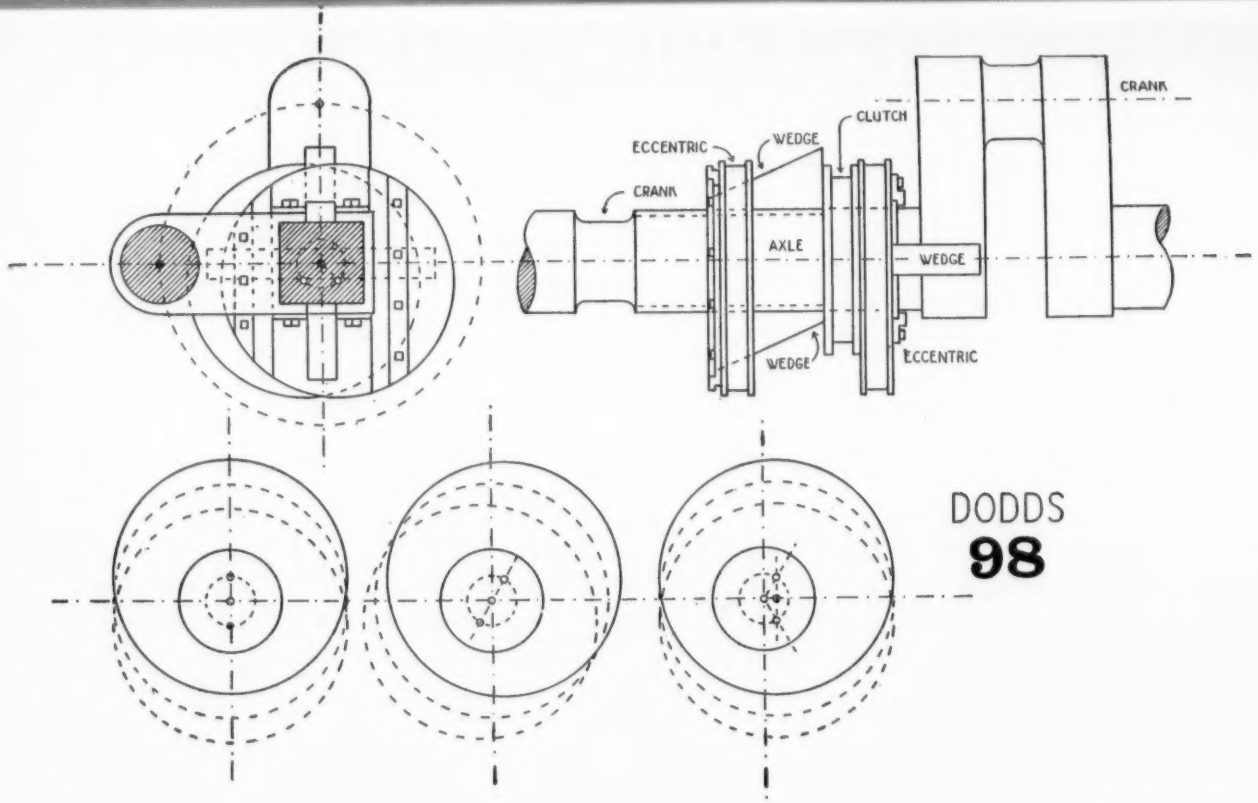
The Wedge motion, invented in 1838, by Dodds & Owen (Great Britain), was in most respects a simple and positive gear. It provided for reversing, but apparently the inventors were unaware how closely they came to arriving at an almost perfect expansion gear. The sketch shows the mechanism as invented, capable of changing the motion of the valve as to direction of running, but not adapted to expansive working.

By a slight changing of the position of the two eccentrics this would have been possible, as is shown by the lower part of the diagram. This plan was adopted some years later, making possible variable travel and constant lead. During the earlier days of British railroading, it was used to some extent, but a fiendish tendency of the edges to stick, or jam, in the eccentric slots proved its undoing. Nevertheless, it provided all the geometrical conditions fulfilled by the link motion and had it not been for the invention of the latter a very few years later, it might have had a far wider application than it did.

Isaac Dodds, the inventor, was a pupil of George Stephenson, and the latter applied the Dodds motion to a number of his locomotives. Thomas Kirtley, Loco. Supt. of the North Midland Ry., wrote to Stephenson in 1844, in part, as follows: "The trifling repairs required to the machinery have been exceedingly little" and "the saving of fuel by these engines is very considerable" also "in point of simplicity it exceeds anything I have yet seen."

So much for a brave attempt to produce a satisfactory valve motion. The improvements noted were made by Henry Dubs, of the famous locomotive building firm of Dubs & Co., Glasgow (later part of the North British Loco. Co. Ltd.).

There was also a similar motion by Fenton, of Leeds, England, in which the eccentrics were guided into their respective positions for reversing and cut-off by a spiral feather on the driving axle. This in 1842.


CRANK
CLUTCH
ECCENTRIC
WEDGE
CRANK
AXLE
WEDGE
WEDGE
ECCENTRIC

DODDS

98

UNIFLOW

(Dwg. 99)

While "Uniflow" can hardly be said to come under the head of valve motions, it is of interest as being something out of the ordinary in locomotive practice.

This system was introduced by Prof. Stumpf, of Berlin, and, while it had been used successfully for a number of years in stationary engines, it was something new to the railway motive power field.

About 1910, the Prussian State Rys. built a class of 0-8-0 freight locomotives with Stumpf cylinders, Walschaerts valve gear actuating poppet admission valves, one at each end of the cylinder.

The outstanding feature of the Uniflow design is the means adopted for the disposal of exhaust steam. Exhaust ports consist of an annular ring of openings surrounding the cylinder, midway between the two heads. The cylinders are somewhat more than 50% greater in length than the normal locomotive cylinder, the stroke of the piston approximating half the length of the cylinder.

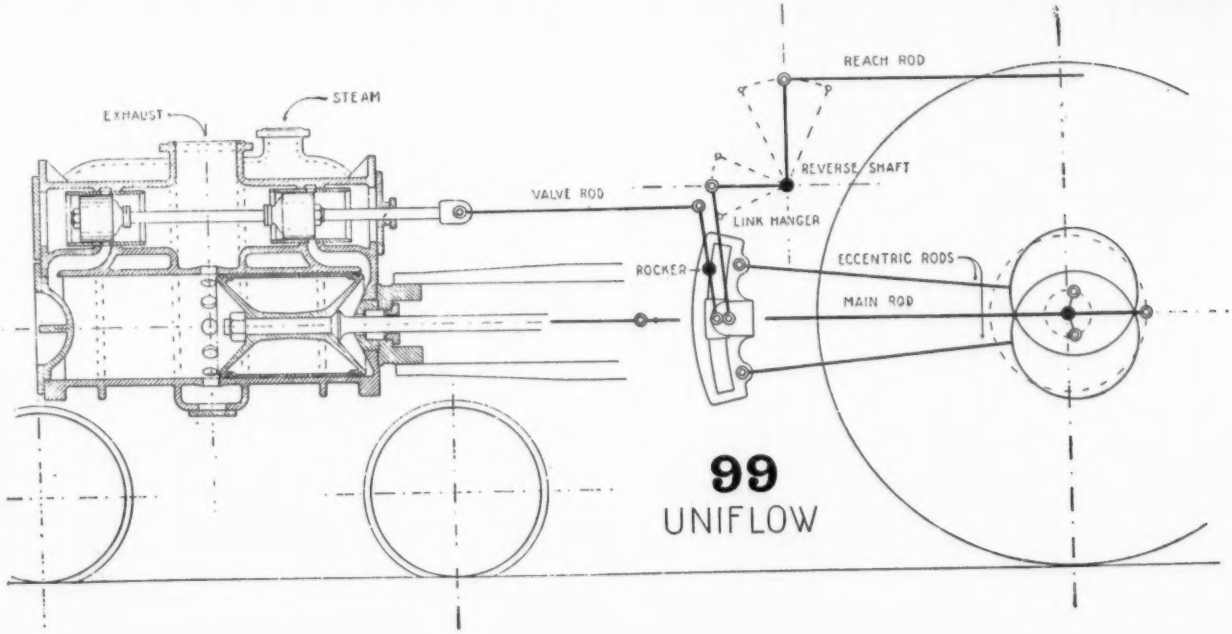
The valve motion may be of any type, the valves being used only for the admission of live steam. Reversing and expansion function in the ordinary manner. Exhaust takes place at 90% of the stroke, the last 10% being used for compression. In order to avoid excessive compression, clearances are made very large. In the Uniflow cylinder steam travels in one direction only, entering at each end, and exhausts from the cylinder as the long piston uncovers the annular ring of ports.

It will readily be seen that this one-way routing of steam has the advantage of doing away with much of the thermal loss from temperature changes in the cylinder walls, due to the passage of the comparatively cold exhaust steam back to the cylinder heads, and through the passages and ports which are so soon to be used again by the hot live steam. It is claimed that this thermal efficiency is equal to that of a two-stage compound. Superheating should improve this.

There are disadvantages too. The cylinders are longer, heavier and more costly than the conventional type, and mean increased weight at the head end. When used with poppet valves, as in the German engine, it is hard to secure the proper amount of compression for the range of work required in locomotive practice. The reciprocating parts are probably no heavier than those in a Vauclain Compound of comparable power.

The arrangement in this diagram is an apparently successful attempt to combat the compression trouble and is the result of experiments carried out by the North Eastern Ry. (England), in 1913. This was with a ten-wheel (4-6-0) passenger engine fitted with piston admission valves actuated by Walschaerts motion.

Valves and ports are arranged so that, when the reverse lever is down in the corner and the valves travelling their full stroke, part of the exhaust steam passes through the ports into the exhaust chamber as with the normal type of cylinder.


REACH ROD
STEAM
EXHAUST
REVERSE SHAFT
VALVE ROD
LINK HANGER
ECCENTRIC RODS
ROCKER
MAIN ROD

99
UNIFLOW

As the motion is hooked up and the valve travel shortened, the amount of exhaust steam passing out at the steam end is gradually reduced, until at a normal running cut-off it ceases to do so altogether. So that we have here an engine that is somewhat of a compromise, working partly as an ordinary one would when heavily loaded, and gradually changing over to the Uniflow cycle with a relatively light load or at high speed.

The drawing shows the final stage of the outside admission design used by the N. E. Ry., as applied to some three-cylinder Atlantic (4-4-2) fast passenger engines. Each cylinder had its piston valve chamber above it, the valves being driven by three sets of link motion with eccentric on the main (forward) axle.

Note. A much earlier application of the Uniflow principle recently came to the writers notice. In 1849, the South Eastern Ry. (England) rebuilt a small 2-2-2 passenger locomotive, numbered 27, with 15″x18″ cylinders and 5′6″ drivers. The cylinders were lengthened to 36″, the additional length being carried out in front of the short smokebox. The steam passages from the front ports to the cylinder heads were about twice the length of the back passages. Ordinary slide valves were used, and any excess pressure due to compression was exhausted by the lifting of the valve. This little engine ran with its Uniflow cylinders for three years.

O. W. YOUNG. (Corliss)

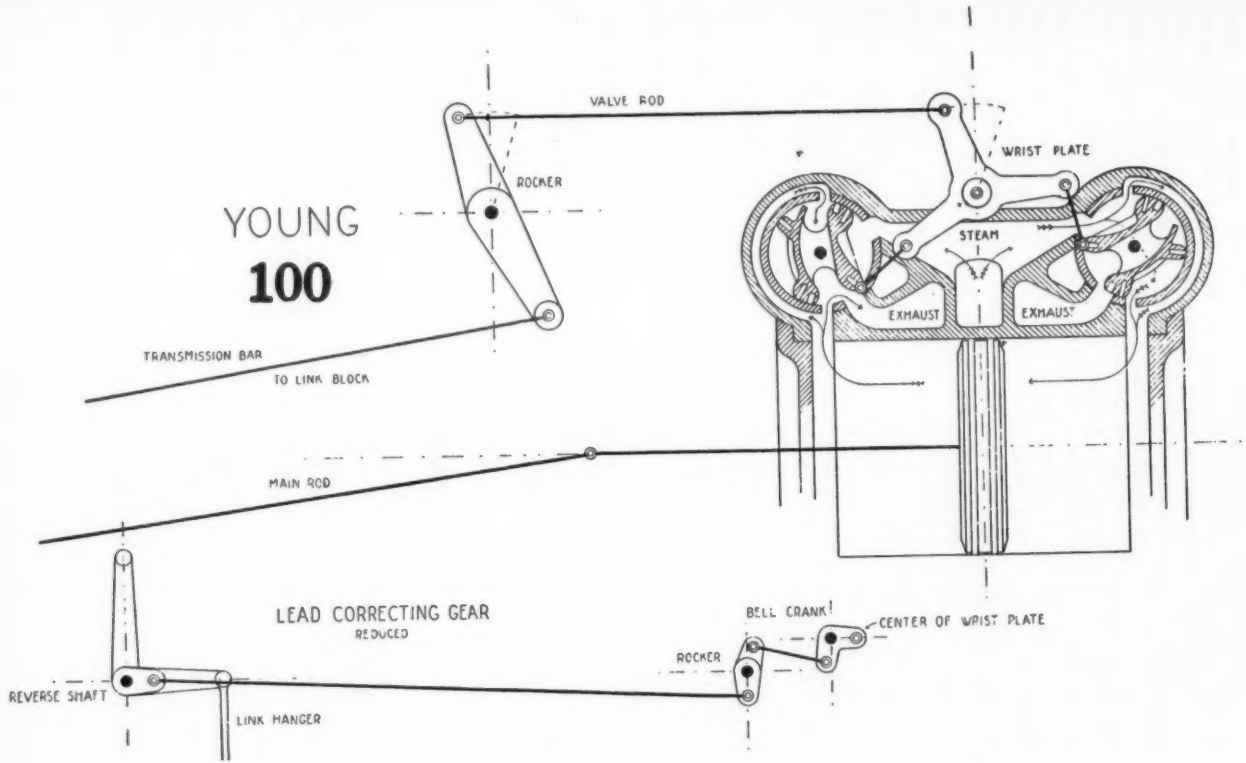
(Dwg. 100)

About 1900 O. W. Young, of Chicago, worked out a valve gear that, at least for a while, gave remarkably good results in practice. It should not come under the head of "motions" because it differs from others mainly in the type of valves used; which may be driven by any of the ordinary valve motions.

The Young system is merely another adaptation of the Corliss type of valve to locomotive use, and a very good one. It was tried out by Robt. Quayle, the then Supt. of Motive Power of the Chicago & North Western road, in both passenger and freight service with promising results.

An examination of the drawing will show two valve chambers above, and extending across the cylinders. These are fitted with cast iron bushings within which the valves oscillate. This movement is derived from the three-armed rocker which we will term the wrist plate, as it performs the function of that member in the Corliss engine.

The drive is through the usual link motion, transmission bar, and rocker, in this case on an Atlantic type engine. The valves are carried on journals at each end of the valve chests, the only wear being that due to the packing strips. Exhaust travels only through the inner part of the valve, while live steam is in contact with only the outer surfaces. The passage of live and exhaust steam can readily be seen by following the arrows.


YOUNG
100
VALVE ROD
ROCKER
WRIST PLATE
STEAM
EXHAUST
EXHAUST
TRANSMISSION BAR
TO LINK BLOCK
MAIN ROD
LEAD CORRECTING GEAR
REDUCED
BELL CRANK
CENTER OF WRIST PLATE
ROCKER
REVERSE SHAFT
LINK HANGER

In the position shown, the gear is in forward motion, with piston at half-stroke and rocker and eccentrics as with the ordinary slide valve.

One of the more serious faults of the link motion and slide valve combination is the difficulty in getting exhaust steam out of the cylinders when running at high speed and with a short cut-off. Young countered this by a device very similar to the variable lead mechanism later used for Walschaerts gear on the Denver & Rio Grande Western. In the Young gear it is used to correct irregularities. A long rod extends from a short arm on the tumbling shaft to a bell crank which, when the reverse lever is moved away from the center, raises the wrist plate, bearings and all. As the engine is hooked up the increase in lead, peculiar to the link motion, is prevented, pre-admission is held down and exhaust clearance provided. This feature is shown separately, in order not to cover other essential parts in the drawing. Its action can be readily understood.

Mr. Quayle, in describing the results of using these valves on a 20″x26″ Atlantic type engine with 81″ wheels, said "There is one run between Chicago and Clinton with usually ten heavy cars, on which this engine is the only one that can make time." At that time the Northwestern's power ranked with the best of its day.

The Young valves gave remarkably good indicator cards, and the engines fitted with these valves showed slight wear and proved good at starting. Their cost was less than a third more than those of the ordinary type. Despite these advantages the Young gear was not adopted by the C. & N. W., for in a few years the Walschaerts motion replaced the Stephenson link.

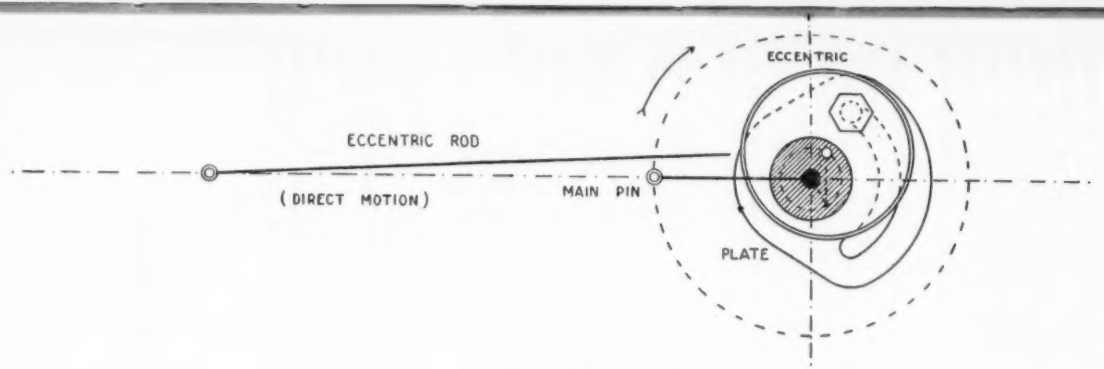
(Young's valves were tried on D. L. & W. No. 1002, a Brooks ten-wheeler, and on D. & H. No. 536, also a wide firebox, center cab, ten-wheeler. On the former the valves were actuated by Walschaerts valve gear, on the latter, by Stephenson. Editor.)

LOOSE ECCENTRIC

(Dwg. 101)

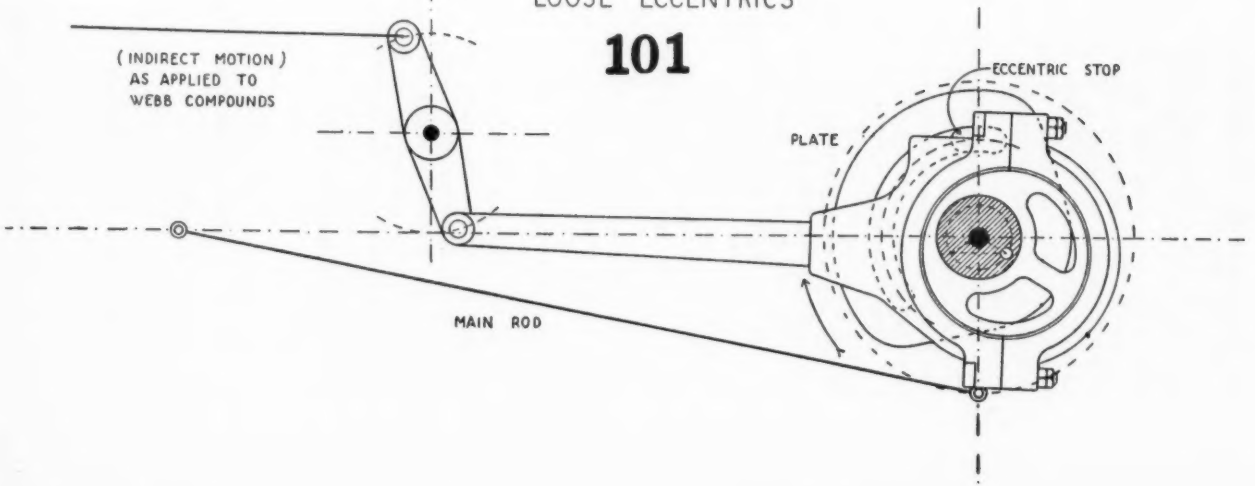
The loose eccentric is not, in itself, a reversing motion in the sense that the direction of running can be changed in the usual manner. If, however, the axle is turned by outside forces, the eccentric becomes adjusted to perform its function of moving the valve in the proper direction.

The upper of the two diagrams shows a loose eccentric for direct (without rocker) drive. Here the slotted plate is keyed or fastened to the axle, and a pin fastened to the eccentric. If the engine is moving in either direction, the stop or end of the slot engages the pin and thus gives the eccentric the proper angular position in relation to the crank pin. In this case it is shown in back motion. Obviously no change



LOOSE ECCENTRICS

101



can be made in the angular advance or point of cut-off once the points of the stop are set.

In the lower diagram is shown a type of loose eccentric adopted by the London & North Western Ry. and, insofar as the writer is aware, this is the only road that has made use of it. The engines were the famous Webb Compounds, the first of which was brought out in 1881. The type might be called a 2-2-2-0, or a 2-4-0 without side-rods. Two outside high-pressure cylinders drove the rear wheels, and a large low-pressure, usually of double the diameter of the high-pressure cylinders, and located directly beneath the front end, connected with the leading driving axle.

Webb's idea in dispensing with side rods was to give the freedom of running inherent in the "Single" engine, so popular in Britain at the time. These compounds showed a substantial saving in fuel, though, as might be imagined, must have given a good deal of trouble in starting.

Originally they were fitted with Joy gear, the valves for the L. P. cylinders being set to cut off at from 70 to 75%. Later the engines of this type were simplified by substituting the loose eccentric for the Joy gear in the forward cylinder, for there was little or no advantage in using any range of cut-off in this cylinder.

In the Webb design the slotted plate is attached to, and virtually part of, the eccentric, the stop turning with the axle. Also the motion is through a rocker, indirect.

This application of the single loose eccentric apparently worked admirably for the Webb system of compounding, but, after Webb's retirement as motive-power head of the L. & N. W., his compounds gradually disappeared. Little success followed efforts to spread their use, though they had been tried on roads in almost every part of the world. The Pennsylvania ordered one when experimenting with the different systems, but it did no better in America than in other countries.

Note. Early in the 1820's, Wood, of the Killingworth (England) Engine Works, used a valve gear having a loose eccentric and fixed stops, which has been thus described: "Fixed upon, and revolving with, the axle was a lever or crank, having at its end a stud, which slid freely in a concentric groove cut in the eccentric. As the axle turned, the stud found its way to the end of the groove, and determined the position of the eccentric for forward or back gear." Which is precisely the arrangement used by Webb.

List of Sources. "101 Valve Motions"

Engineering News.
Locomotive Engineering.
Locomotive Magazine (London).
Locomotive Encyclopedias.

Development of the Locomotive Engine. Sinclair.
Locomotives and Locomotive Building in America. Forney.
Catechism of the Locomotive. Forney.
The Locomotive Up to Date. McShane.
100 Years of Locomotive Building. Warren.
Recent Locomotives.
Mechanical Drawing. McLay.
Locomotive Valve Motions. Yoder & Wharen.
Treatise on Valve Gear. Zeuner.

Lot 646

By C. L. Collom

(An account of some of the narrow gauge railroads of the Pennsylvania oil region, as reported in contemporary issues of the *Warren Mail, Warren Ledger, Forest Republican* and their exchanges.)

Railroads have been important to the oil fields ever since the Oil Creek Rail Road was so hurriedly built during the summer of 1862. The narrow gauge lines came into their own as a principal means of transportation in the oil fields during the Bradford oil rush. This is the story of another oil rush and of other narrow gauge roads on a hilltop in western Pennsylvania.

In 1880, the Bradford field was reaching the saturation point as far as speculation was concerned, and the "wild catters" were looking for new fields and enlarging old ones. The Glade (Warren) field was enlarged to and around Clarendon, and new wells were put down at the Foxes (Blue Jay) and Balltown, in Forest County. These proved to be good, though not great, fields, and the lease men and scouts started to trek to Clarendon, as a new field of operations, the Philadelphia & Erie putting on an extra train just to take care of them. Bradford, now anxious for a connection to this new field, started to build the Olean, Bradford & Warren extension, which Titusville and Warren had been unsuccessfully promoting, in the form of the Bradford and Kinzua railroads, ever since the O. B. & W. was first built. The Philadelphia & Erie, and Horton & Crary, tanners, started lines toward Foxburg, Forest Co., and the Blue Jay field. Numerous other railroads and small fry were surveying or building over the hills and in the valleys of Warren and Forest counties. The Pittsburgh, Titusville & Buffalo was being built up the Allegheny, from Warren, to Salamanca and Olean, and the Company was also trying to promote a line up Tionesta Creek, from Tionesta to Sheffield. The Vanderbilt interests, behind the recently completed Dunkirk Valley & Pittsburgh, were surveying from Warren to the coal fields of Jefferson County.

Late in January, 1882, the Jamestown Oil Company started a wildcat well on Lot 646, in Cherry Grove Township, Warren Co., six air-miles from Clarendon. By late March, the well was known as the "Mystery Well," and was surrounded by greatest secrecy. Tanks were built, but whether they were to sell a "duster" or to really hold oil only the drillers and the owners knew. When, in April, more tanks were delivered, there was much conjecture, and, with memories of the great and still-continuing profits of the Bradford narrow gauge roads, railroad promoters got busy on the lines to Cherry Grove and Lot 646.

In April, the Warren & Farnsworth Valley R. R. was chartered and sent engineers to locate a line up the Farnsworth Branch, across the ridge, and down the Minister to the Tionesta, thence up the Logan to Marienville to meet the Pittsburgh, Bradford & Buffalo, then building from Foxburg to Kane. Two weeks later Clarendon was a busy railroad

town, having three railroads under construction, the W. & F. V., the Clarendon & Tionesta, and an unnamed line. Mr. Horton, of the Horton and Crary Co., whose Tionesta Valley R. R. was then running to Brookstone, where it turned when blocked by the Philadelphia & Erie's grade, said they would build to Cherry Grove, if the well proved good.

The engineers of Vanderbilt's Warren & Jefferson located a line through Balltown and Cherry Grove, a mere gesture it was said, as no sane engineer would have taken a coal hauler up and down that hill for a little local traffic. During May, the W. & F. V. apparently had the field to itself, and, under Contractor Towell, was pushed on toward Garfield, as the boom settlement was known. The O. B. & W. and the Pittsburgh, Buffalo & Western (P. T. & B.) opened their Bradford Short Line.

On May 23rd, newspapers announced "Oil at Lot 646," and called it one of the largest wells in recent years, with land selling at $2.00 per foot. The Mystery Well flowed 9,500 bbl. of oil in its first ten days. The lease men and scouts of the oil business converged upon Cherry Grove, business boomed, and the P. & E. put on more passenger trains to Clarendon and Sheffield. Titusville interests looked over that part of the never-finished Pennsylvania Petroleum Co. R. R., from Titusville to Hickory, and the possibility of a new line from there to Garfield. The former had been graded to Hickory and some bridges had been built.

By June, the wells were producing "Rivers of Oil," the Murfey well's production rising from 610 to 1000 bbls. per day, and the Cadawaldus rising from 635 to 2000, in three days. Such production demoralized the oil trade men, who had been making a good living from thirty-barrel wells, and now faced ruin. The D. A. V. & P. put on a special oil train to the refineries at Titusville. The P. & E. put on more trains to Clarendon. The sidings at Clarendon and Farnsworth, where the plank roads of the tanneries brought bark down off of the hill, were jammed with cars of oil field equipment. Titusville and Oil City interests talked of a railroad up Tionesta Creek. Already there were six gushers in and around Lot 646, and the newspapers announced the arrival of an engine for the W. & F. V. The narrow gauge line from Foxburg, almost completed to Kane, announced that it would build to a connection with the Tionesta Valley, at Brookstone. Between Farnsworth and Farnsworth Siding, on the P. & E., "Four hundred teams pass each other on the road each day, people walk, and the road is lined with spruce-beer stands, sandwich shops and barrel-head whiskey bars."

The W. & F. V. worked frantically to get its road in operation. Money was plentiful and people were eager to invest in railroads and reap some of the twenty-five, to nearly one hundred per cent profits, paid by some of the other oil field narrow gauge roads. In July, four more narrow gauge lines were chartered, viz., Garfield & Cherry Grove from the P. & E. at Tiona, to Garfield; Bradford & Tiona, from the O. B. & W., at Kinzua, between Marshtown and Anderson, to Tiona; Garfield & Tionesta, from Garfield to Tionesta, on the Allegheny River;

and the Tionesta & Clarion, which was not directly connected with the present excitement. In this same month, the W. & F. V. received its second engine, the Mystery well still averaged 1000 bbls. per day, and seventeen wells in the Cherry Grove field averaged 21,600 bbls. per day. The P. & E. was running seventeen trains daily from Warren to Clarendon. Passenger receipts at Warren, for June, as reported by the P. & E. were $7,108.00, by the B. P. & W., $3,392.00. The contractor on the W. & F. V. construction was paid a bonus of $200.00 per day, for each day saved on the contract, the standard contract for narrow gauge construction being "$100,000 and ninety days," one of the apparent causes of the narrow gauge network being built almost entirely in ten- to fifteen-mile units.

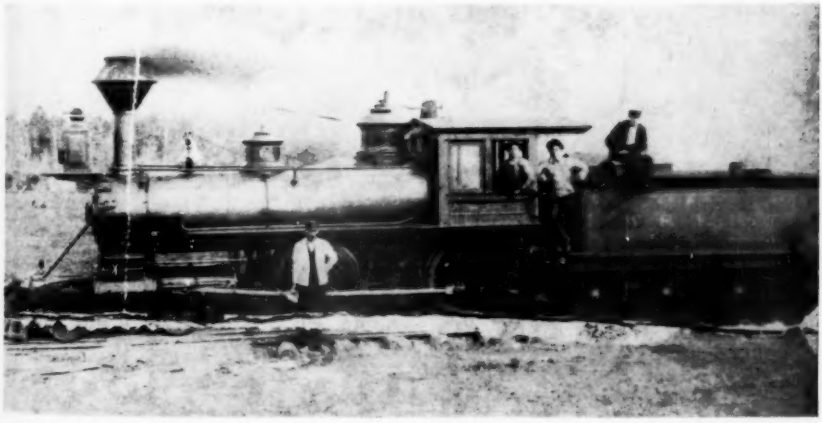
The narrow gauge lines of the Bradford field shipped materials to their standard gauge connections in such a way as to swamp them, blocking main tracks and sidings, and resulting in much bribing of railroad men to get cars moved.

It was rumored that a number of the proposed narrow gauge roads would combine under the name of the Bradford Air Line. So numerous were these roads that a farmer, from near Cherry Grove, in the office of the *Warren Mail* said that he had tied seven chickens to seven stakes in his front yard, and that each stake represented the location of a different railroad!

A contemporary Buffalo paper reported the following items regarding the W. & F. V. Eleven miles of main line, including a wye, have been built, and the road will be extended two miles beyond the present terminus. The road was commenced on April 29th, and was to have been completed in three months, which has been slightly bettered. The greatest grade is 105 feet per mile, the sharpest curve of 20 degrees. Four trestles and two Howe truss bridges have been built over the Tionesta and Farnsworth Creeks. The platform, and freight and engine houses at Clarendon have been completed and the passenger station is being erected. Being close to the P. & E., the transfer of passengers and freight will be convenient. Equipment of the road consists of three locomotives, twenty flat cars, ten gondolas, six box cars, and three passenger cars. Cost of the locomotive is said to be $8,700.00, and the best passenger coach, built by Brill, of Philadelphia, cost $2,800.00. This coach is furnished with a system of steam pipes for heating, and will seat forty passengers. The other two coaches were made in York, Pa., and seat forty-two. They are forty-two feet long and equipped with Evans (?) Vacuum brakes. The fare for the half-hour trip to Garfield was eighty cents. The cost of construction and equipment was about $12,000.00 per mile. The work was under supervision of Chief Engineer Wood, who had laid out the Oil Creek R. R. some twenty years before.

In the middle of August, the bubble burst, when the field proved to be a pocket, the rock structure reacted poorly to the torpedoes, and the wells went down rapidly. However, the G. & C. G. completed its survey, and the T. V., extending from Brookstone to the P. B. & B., at Beechwood Jct. (Sheffield Jct.), built its long, high trestle in the valley

Tionesta Valley #5. ex-Warren & Farnsworth #5. Built by the Wyoming Valley Machine Co. C/N 120, 1880.



Warren & Farnsworth #6. Later Tionesta Valley #4. Built by the Wyoming Valley Machine Co.

above Brookstone. The Bradford & Oil City Air Line continued to push its "Grandest Narrow Gauge in America," planned to consist of the Bradford & Garfield Air Line, from Bradford to Anderson, twenty miles, the B. & T., on to Tiona, twelve miles, the G. & C. G. to Garfield, ten miles, the G. & T. to Tionesta, twenty-eight miles, and the Tionesta & Oil City, to Oil City, nineteen miles. Passenger receipts were still large at the Warren depots, totalling over $15,000.00, in August.

By October, grading of the G. & C. G. was finished from Tiona to Garfield, and the connection from Tiona to the Tionesta Valley was also graded, with ties and iron on the ground, and the locomotive due to begin service in November. At this point there came a downward turn in passenger receipts.

The Fall of 1882 was probably the high point of these narrow gauge roads. The Pittsburgh & Western was gathering in such lines from Pittsburgh to Bradford, and was building to a connection with the Ohio lines that reached out to St. Louis. Sometime during the building of the P. & W. to Youngstown, O., its gauge was changed to standard, and the narrow gauge lines and Lot 646, after their brief hour of glory, began their decline, each, undoubtedly affecting the other.

In January, 1883, papers reported the B. & O. C. Air Line in a bad way, with "twelve miles built and equipped, but without business." The contractor, A. Dreisback, wanted the money due him and attached the road, and the cashier, one Tingley, was absent. The W. & F. V. was pushed on to Vandergrift City, and looked down the Minister to the Tionesta, where the P. B. & B. proposed meeting it with a branch down the Blue Jay. The perennial favorite of northwestern Pennsylvania, the Penna. Petroleum Co. R. R., surveyed through Warren County as the Erie Southern Crestline, on its way to Elk County.

In the Fall of 1883, Garfield staged a comeback in the form of pumpers and transits, on its way to Balltown and Porcupine, and the *Bradford Era* published an article indicating that the T. V. was operating freight trains into Garfield, over the uncompleted, as yet, G. & C. G. The W. & F. V. built on to Dunhams Mills, in 1884, the farthest point it was ever to reach along the hill. Horton & Crary became interested in extending it and got a charter for the Cherry Grove & Hickory Valley, to build to Hickory, on the Allegheny, and upon this road hung the future of the narrow gauge system of northwestern Pennsylvania. If built, the Garfield & Cherry Grove would have extended its line to the O. B. & W. branch of the B. N. Y. & P., and the B. & O. C. A. L. would have built from Oil City to Hickory, but the project was never carried through.

On Sunday, May 25th, the G. & C. G. ran an excursion over the road, before opening it for business the next day, to connect with all P. & E. trains, and all but one on the T. V. There was not enough business in Garfield to support two railroads and, in the Fall, and, through a Sheriff's sale, on October 24th, it passed to the Horton and Crary interests, who leased it to the T. V., as the Cherry Grove R. R., in December, 1884.

In later years, the P. B. & B., by then known as the Pittsburgh & Western, made several half-hearted attempts to connect with the W. & F. V., by way of Blue Jay, and a logging railroad, the Iron City, was built on this grade, but it never got more than partway up the hill.

In 1885, the W. & F. V. was reorganized as the Warren & Farnsworth. In 1894, when the Horton and Crary holdings were sold to the Pennsylvania leather interests, the T. V. and its various parts, the Tionesta Valley Railroad, the Cherry Grove, and the Sheffield & Spring Creek, were organized, along with the W. & F., as the Tionesta Valley *Railway*. That portion of the Cherry Grove, up the Little Arnot, was torn up, and the long-forgotten Tionesta & Clarendon was built. In later years, various branches and trams were built by the T. V., up the Big Arnot and the main branch of the Tionesta, to Stoneham, and, as the Rogers Railroad, extended to the end of the bridge at Warren. The line up the main branch of the Tionesta was the last of the narrow gauges to Cherry Grove, as the forests that covered the hill went through the saws of the Sheffield and Rogers mills.

Now they are all gone, even to the whistles of Wheeler and Dusenberry's standard gauge line that came up from the Allegheny on the proposed route of the C. G. & H. V., where, for years after the narrow gauge had deserted the hill, engines of the Hickory Valley still battled the hill with rack cars of chemical wood, which slipped down the switchback to the plant at Mayberg. Even the valley of the Tionesta has lost its own Sheffield & Tionesta, which finally wore out, and died at the request of the I. C. C.

Apparently the W. & F. had six engines, their Nos. 5 and 6 becoming Nos. 5 and 4 on the T. V. The Cherry Grove's lone engine became T. V. No. 3, but after a rather short and distressing career, went to an early grave.

Following are a few railroads that were surveyed, projected or built through the valley of the Tionesta or near Sheffield during this period.

Tionesta Creek (Standard gauge)
Sheffield & Blue Jay (Narrow gauge) (TV)
Tionesta Railway (SG)
Clarion, Mahoning & Pittsburgh (SG) (W&J)
Conewago & Clarion (SG) (W&J)
Rochester & State Line (SG)
Tionesta & Allegheny Valley (SG)
South Branch & Forest County (NG?)
Sinnamahoning & Sheffield (NG)

The Magnolia Cut-off

How the B & O Broke "The Neck of the Bottle" to Speed Up Freight Movements in the Upper Part of the Potomac Valley

By Francis E. Riffle

Soon after he became president of the Baltimore & Ohio on Jan. 1, 1910 it became apparent to Daniel Willard that the road would have to be rebuilt, and subsequently enlarged at many places, to make it an effective modern carrier. Headed by a highly expert traffic man, Oscar G. Murray, the B & O was skilled in the solicitation of traffic, yet many times the road failed in the handling of it. Blockades of cars and of trains and their resultant delays were all too frequent on the system. Being an "operating" man, Willard was interested in increasing the efficiency of the system and improving its services.

The new president first set about placing his road in shape financially to handle the increasing amount of freight being offered. He borrowed $62,000,000 so that he could regrade and add extra tracks to the right-of-way, improve and add to the motive power and car fleet, and build new terminals and shops. Six millions of this was earmarked for the Magnolia Cut-Off Improvement program.

The need for additional facilities east of Cumberland, Md., particularly between Cumberland and Brunswick, Md. had been felt for a number of years. The handling of bituminous coal from the coal fields of Maryland, West Virginia and Pennsylvania to tide-water, together with the comparatively heavy movement of fast freight, having taxed the facilities on this part of the road. On this freight run of 102 miles, there were three helper grades, two of which were between Patterson Creek and Martinsburg, the section of greatest density of traffic. The North Mountain helper grade, six miles in length, was eliminated for slow freight, in 1903, by construction of a 0.3 percent low grade line around the mountain between Cherry Run and Martinsburg. The first, or Hansrote, helper grade was an 0.8 percent ascending grade against eastbound traffic, and was two and one-half miles in length. It was on account of this helper grade and the very rough country, together with the circuitous route of the river, that this section of the road remained unimproved pending decision in regard to a general change which would eliminate the helper grade, shorten the line and reduce the curvature.

In the coal fields of Maryland, West Virginia and Pennsylvania new developments were constantly being made and additional facilities added to take care of the requirements as rapidly as the business increased; the situation east of Cumberland was gradually growing acute. It had been felt that the rapid growth of the business made possible by the additional facilities west of Cumberland, would result in an over-balance, causing a condition of having more business than could be handled on the line east of Cumberland.

As early as 1900 congestion east of Cumberland was serious at various times and a number of improvements, including the Magnolia Cut-Off, were considered, but owing principally to the heavy expenditure necessary to add to the track facilities along the Potomac River, they were postponed from time to time.

Mr. Willard, who was at that time Assistant General Manager, stated that the problem was a serious one and surveys and studies were made for the purpose of determining the best and most practical way to alleviate the situation.

Additional surveys and studies were made at various times to locate the most economical line from the standpoint of operation as well as first cost. In 1902, Mr. L. F. Loree, then President of the Baltimore and Ohio, had exhaustive studies and surveys made for the purpose of solving this problem, as serious congestions occurred on this portion of the road at that time, but the financial depression of 1903 prevented definite action being taken. Again in 1906 Mr. Oscar G. Murray, who suceeded Mr. Loree as President, had the matter looked into with the result that a line was adopted, but the depression of 1907 prevented anything being done at that time, when it was thought that a new four track railroad, eliminating the old line, costing $15,000,000 was the solution to the problem

It remained for Mr. Willard, who returned to the Baltimore and Ohio in 1910, to solve this problem, which was one of the most serious that then confronted the management. From the time he took office until the problem was solved, constant thought was given to working out this difficulty by the most economical and effective methods.

From a train movement chart indicating a twenty-four hour movement on the territory under question for a typical day in 1913, it is readily seen that lack of track facilities limited the operation on that portion of the Cumberland Division between Patterson Creek and Cherry Run, and that the territory properly became known as "The Neck of the Bottle." The handling of the passenger and fast freight business promptly through a territory of such density of traffic and limited facilities was a problem not difficult to appreciate. As indicated by the chart, the slow movement was on the helper grade between Hansrote and the summit at Doe Gully Tunnel, where frequently freight trains on the eastbound main and side tracks waited for track and helper engines. As readily noted from the chart, the congestion occurred (on the day in question) at the foot of the helper grade between Magnolia and Hansrote. Both day and night six or seven eastbound freight trains were in the vicinity of Hansrote helper grade either moving or waiting for track. On account of the helper engines using the westbound track down the grade the traffic westbound was frequently delayed, the delay of helper engines in turn delaying eastbound trains.

At that time the greatest density of traffic on the Baltimore and Ohio system, that is, number of trains handled, as well as ton miles per mile of road, occurred east of Cumberland, between Patterson Creek

View looking east (Sept. 1914) from the east end of Doe Gully Cut over the four-track fill towards Orleans Road. A portion of contractors plant appears on the left.

Present day view from same location.

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View looking east (July, 1914) through Doe Gully Cut. It will be noted that about the middle of the view the bench was lost by a small slide.

Present day view looking east through Doe Gully Cut. Tracks to right are the Cut-Off tracks. West portal of old Doe Gully Tunnel was at the approximate position of the white post in front of east-bound freight train.

and Martinsburg. There had been handled annually 20,000,000 net tons of freight per mile of road between the above mentioned points, and an average of 15,000,000 net ton miles per mile of road over the entire freight division from Cumberland to Brunswick, the traffic being divided as follows: 14.3% fast freight, 84.0% slow freight and 2.2% package local. In 1913, the year of the greatest tonnage handled (up to that time) on the Baltimore and Ohio, there was a 25.8 per cent increase over the year 1910.

With such increasing business, the necessity can readily be appreciated for a change in the methods of handling traffic in this territory in order to take care of additional business, then presenting itself, the congestion on this part of the line being very disturbing.

Prior to the Magnolia Cut-Off Improvement, the East End of the Cumberland Division was a double track road forming one freight division, 102 miles long, and extending from Cumberland to Brunswick. At Cumberland two double track lines, one from Pittsburgh and Chicago, the other from Cincinnati and St. Louis, met and formed the main line east, as at present. At Patterson Creek, 8.1 miles east of Cumberland, a freight cut-off joined the main line from the Cincinnati-St. Louis line which eliminated handling this freight through Cumberland. These two double-track lines merged into a three-track road from Patterson Creek to Little Cacapon 13.9 miles, at which point there was a westbound passing siding. From the latter point to Magnolia, 7.5 miles, there were but two tracks with a westbound passing siding at Magnolia.

An additional freight running track was provided from Magnolia to Hansrote 5.5 miles, at the foot of the helper grade. From Hansrote to Orleans Road, 4.7 miles, there were two tracks with an 0.8 percent helper grade eastbound against the ruling movement from Hansrote to the summit at Doe Gully Tunnel. From Orleans Road to Cherry Run, 25.3 miles, there were three tracks with a four-track section from Sir Johns Run to Hancock 5.1 miles.

At Cherry Run the main line, which was double tracked, ascended an 0.8 percent grade for a distance of 7 miles to the summit at North Mountain. From Cherry Run to Cumbo, there was a low grade eastbound double-track freight line 14 miles in length which passed around North Mountain and joined the main line again at the latter point. From Cumbo to Fawver, three miles, there was a double-track line and from Fawver to Opequon, the foot of a helper grade, there were three tracks, the third being an eastbound running track. An 0.8 percent ascending grade began at Opequon, which continued to the summit at Hobbs, 7.3 miles. From this point to Engles, near Harpers Ferry, 5.8 miles, there was a double-track line with an 0.8 percent descending grade and a west-bound third track.

From Engles to Weverton, 6.2 miles, there was a double-track line. Brunswick Yard, the east end of the freight division, is situated immediately east of Weverton.

The division was operated for a general grade of 0.3 percent eastbound, using helper engines over the two 0.8 percent grades.

The low grade around the second summit between Cherry Run and Martinsburg was completed in 1903, eliminating the use of helper engines on a six-mile helper grade between those points. With the completion of the Magnolia Cut-Off, helper engines at Hansrote were eliminated, permitting a continuous movement of freight trains between Cumberland and Martinsburg, the part of the road of greatest traffic density, where helper engines were formerly necessary. From Martinsburg east over the third summit the services of helper engines were continued until grade improvements were made between Martinsburg and Harpers Ferry some years later.

Ten miles east of Brunswick at the east end of the freight run under discussion, the main line diverged into two double track lines; one to Washington and one to Baltimore. On the line to Baltimore, the Adamstown Cut-Off, a low grade line, eliminated the necessity for helper engines over one summit.

The heavy eastbound traffic over the double-track congested part of the East End of the Cumberland Division in the latter part of 1910, particularly the tidewater coal business, caused so much anxiety on the part of President Willard and his operating officers that conditions in this territory were given particular attention and study with a view of taking care of the business offered at that time as well as to provide for increased business.

Had the revision of grade and line schemes for the Magnolia Cut-Off all been worked out and decided upon, and the money appropriated, completion of the work could not have been accomplished in time to take care of the increased business offered. It would have required at least eighteen months to two years to complete any scheme presented for the Magnolia Cut-Off, and from four to six months to get any relief whatever from third tracks along other portions of the division.

It was necessary to do something at once other than arrange for additional tracks in order to relieve the congestion. Existing financial conditions demanded exceptional care in making expenditures and means were sought to improve operating conditions so as to meet the demands of a rapidly increasing traffic without making the heavy expenditure at this time necessary in the construction of the Magnolia Cut-Off.

In order to secure immediate results, it was decided to: 1) Order Mikado locomotives for immediate delivery, 2) Construct additional automatic signals and build third tracks where they could be laid on that portion of the line not affected by the proposed Magnolia Cut-Off, 3) Establish signal indication for the operation of trains, and 4) Provide more and better supervision.

At first attention was given to reducing the number of trains to be handled by using first class Consolidation locomotives, establishing their maximum tonnage by dynamometer car tests, thus obtaining the maximum number of net ton miles per train mile. This type of locomotive was the heaviest used in 1910 in B & O freight service; it weighed 220,370 lb. and had a tractive power of 42,000 lb. Then a vigorous

campaign was started for a better carload, a decrease in the number of cars hauled and an increase in the number of revenue tons per train.

It was an opportune time, as to delivery and price, to purchase locomotives. A Mikado type of locomotive was decided upon, designed, and a sufficient number ordered to equip the East End of the Cumberland Division. These locomotives which weighed 284,500 lb. and had a 55,000 lb. tractive power, provided 26.2 percent greater hauling capacity than the Consolidation type locomotive.

The various passing sidings and freight tracks both east and west of the seventeen-mile section of road which was to be improved by the Magnolia Cut-Off, were coupled and extended to this section, thereby securing maximum freight running trackage for a considerable distance at each end of the proposed improvement.

Interlocking towers were placed five miles apart and crossovers constructed between tracks, to permit of parallel movements. Where three tracks were available, the middle track was equipped with automatic signals to permit of movement in both directions. All three tracks were laid on stone ballast and surfaced for high-speed trains. The movement of trains in this district was also placed under signal indication, eliminating train order movements, the third track system particularly lending itself to increased efficiency because of its flexibility in permitting of almost a four-track operation. No. 16 crossing frogs were installed in cross-overs, which when used were covered by upper quadrant slow-speed signal blades.

A main track coaling tipple, ash pits and water facilities were placed at Sir Johns Run, half way on the freight run east from Cumberland; this section, five miles long, was arranged on a four-track basis. These improvements and facilities made it possible to take care of a very heavy business, which was particularly desirable—in fact, necessary—and also produced a reduction in the cost of operation.

Additional supervision was placed on this part of the road and consisted of a force of well-trained men, who were placed both on line of road and in the Superintendent's office. Particular attention was given to following the make-up of trains, to reduce the number of breaks-in-two to a minimum, and further to see that each train was given its full tonnage rating. Inspectors were also placed in the coal regions, to see that each car was loaded to its capacity. In four years, from 1910 to 1914, on the East End of the Cumberland Division, the average carload increased 13.4 percent. The increase in average capacity of system cars during the same period was five tons, or 13.5 percent.

With the improved operations mentioned above it was possible to: 1) Take care of a rapidly increasing business, 2) Postpone for three years the construction of the Magnolia improvement, thereby saving the interest on a large sum of money that would otherwise have been expended immediately, and 3) Provide additional time for studies of the contemplated line revision.

In taking up the study of the Magnolia Cut-Off Improvement as it related to the East End of the Cumberland Division, it was necessary to determine the ruling grades both east and westbound on this division. Before this was done a careful study covering a period of several years was made of the train movement and the tonnage handled, and the question of motive power was also investigated so as to forecast the future locomotive tractive power and train load. The relation of the loaded eastbound movement to the empty westbound movement was also carefully studied.

It was finally decided that an eastbound grade of 0.1 percent was possible, which would permit the most economical operation, and that a westbound 0.4 percent grade would take care of the balance of traffic in that direction.

The question as to the construction of a new two- or four-track line was given a great amount of study, and it was found that a low grade four-track line would eliminate the old line entirely, while a low grade two-track line would retain the present line. In this connection four possible propositions were definitely considered, involving the construction of: 1) Temporary third track along the old line, retaining eastbound helper grade, 2) Additional tracks, providing four tracks along the old line and retaining the helper grade, 3) Four-track low grade cut-off, abandoning the old line, and 4) Two-track low grade cut-off for freight, using the old line for passenger and express trains.

In reaching a decision between the various grade studies the consideration was constantly in the minds of the engineers, provided it was intended to maintain the old line tracks, that the new line would have to rise sufficiently to cross above the operated tracks at Magnolia and again at Kesslers.

Before the line was finally adopted a large number of variations of the four different general schemes were studied. A total of 29 propositions were covered which varied in grade and alignment, following three distinct routes. The various studies included plans for building the new line in parts, to be extended over a term of years. The estimated cost of these lines varied from $1,425,000 to $15,575,000.

The present line was finally adopted by President Willard and the Board of Directors and construction authorized on March 13, 1913, at an estimated cost of $6,000,000, charging to Additions and Betterments a total of $5,325,000 and to Operation $675,000, upon the basis of the rulings and classifications of the Interstate Commerce Commission.

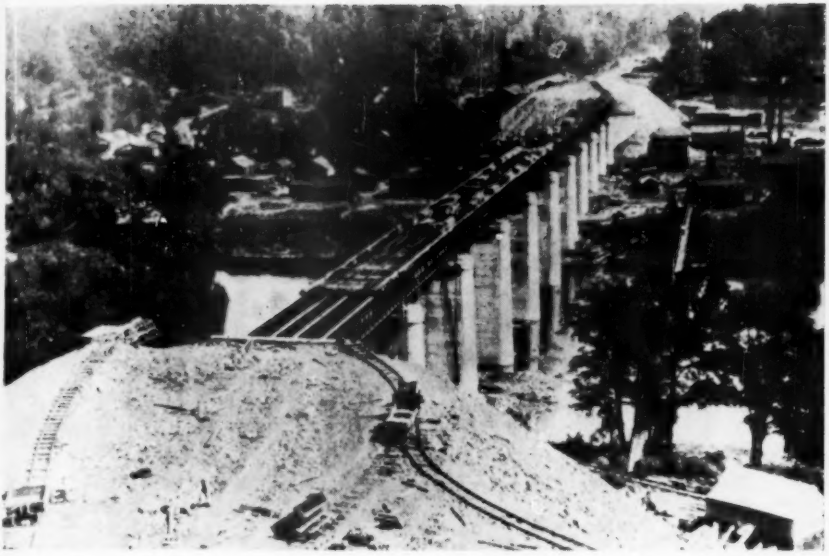
The Magnolia Cut-Off begins at AD interlocking tower, Orleans Road, W. Va. on the east rising on a 0.4 percent compensated grade to a summit immediately west of Doe Gully, where it begins to descend westward on a 0.1 percent compensated grade to NO interlocking tower, Okonoko, W. Va., a total distance of 13.2 miles. As compared with the old line, a saving of 5.7 miles in distance and 877 deg. in curvature is effected. From east to west the main features are as follows:

View looking east (Sept. 1914) through Doe Gully Cut taken from a point immediately above the east portal of Randolph Tunnel. Old Doe Gully Tunnel can be seen in distance.

Present day view from same location.

View showing east approach from a point directly above the east portal of Stuart Tunnel. This cut required the removal of over 200,000 cu. yds. of rock.

View showing west portal of Stuart Tunnel and the west approach cut. Considerable difficulty was encountered in the excavation of approximately 90,000 cu. yds. of rock from this cut on account of the almost vertical dip and badly broken strata.



View showing steel placed on Magnolia Bridge, looking east (August, 1914). The town of Magnolia is noted on the West Virginia side of the river and the contractor's plant to the left of the fill at the east end of the bridge.

Present day view of Magnolia Bridge taken from a point immediately above the east portal of Graham Tunnel. Old line tracks pass beneath bridge on West Virginia side of river.

Beginning at AD tower, the three-track line which extends westward from Sir John's Run fans out into four tracks, the two tracks on the south side being "High Line" or Magnolia Cut-Off. At a point 1,000 ft. west of the interlocking tower the four tracks enter a long, sweeping curve along a hillside cut to emerge on a large embankment containing nearly 1,000,00 cu. yd. of material taken from Doe Gully Cut. Before the construction of this embankment the old line tracks were located a short distance to the south along the hillside, the relocating of these tracks permitting a 4 deg. curve instead of one of 6 deg.

At a point on the above curve the swift-running waters of Rockwell Run pass through a large culvert well below the four tracks. This mountain stream, which flows into the Potomac River just to the north of the tracks, provides water for the Rockwell Run water station. This rarely-used station has its storage tank to the south of the tracks and is provided with twin penstocks to enable engines to take water while on either of the four tracks.

The line continues on a 0.4 percent ascending grade through the ridge west of Doe Gully, where an open cut was excavated for four tracks by removing the old 1,208-ft. long Doe Gully Tunnel. This brick-lined tunnel, which was built in 1842 and which later was to become a "bottle neck," had a width of 21 ft. and a height of 20.5 ft., affording room for two tracks. The fronts or facades of the arch of this old tunnel were of a fine white sand-stone, procured from the summit of the neighboring mountain.

The Cut-Off continues to a point 500 ft. west of the west portal of the old tunnel where it diverges from the old line tracks on the south side. It then descends with a 0.1 percent grade and instead of following the Potomac River around the point of a ridge, as does the old line, the Cut-Off passes through Randolph Tunnel, which is 1,014 ft. in length. The old line tracks pass through the extreme tip of the ridge by means of narrow, curving Murray's Cut.

Then continuing with a 0.1 percent descending grade, the new line follows the old line tracks, rising about 40 ft. above them on the side of the hill to Hansrote where the two lines again part company, the Cut-Off diverging to the south and passing through the divide by Stuart Tunnel, 3,355.4 ft. in length. The old line, between this point and Kesslers (where the two lines again meet), pursues the very sinous part of the river lying between Sideling Hill on the east and Town Hill on the west. The curves are not however abrupt, but form fine sweeping circuits, passing sometimes along beautiful alluvial bottoms and again at the foot of precipitous cliffs.

At Hansrote, a 3,900-ft. connecting track is provided to form the only intermediate connection between the old line and the Cut-Off tracks. Trailing point cross-overs are provided at this location between the respective tracks of the two lines.

The Cut-Off emerges from Stuart Tunnel at Magnolia practically at right angles to the old line, which it crosses overhead by means of Magnolia bridge extended. The difference in elevation of the two lines

at this point is 50 ft. Crossing the Potomac River into Maryland it continues on the 0.1 percent descending grade and passes through the ridge by Graham Tunnel, 1,592 ft. in length, thus cutting off a long loop made by the river around the hill, saving about two miles in distance. The old line tracks follow the long loop of the river by means of Steer Run Curve.

Emerging from Graham Tunnel the line again crosses the river to Kessler's Curve, W. Va., the bridge crossing the old line tracks overhead.

Then still descending with a 0.1 percent grade through a small cut, the line follows along the steep hillside on a bench about 40 ft. above, and south of the old line tracks. On account of the bluff being almost sheer to the old tracks, a concrete retaining wall 1,800 ft. in length was provided between the old and new tracks. West of this inter-track wall the new line again diverges from the old for a short distance and passes through Carothers Tunnel, 995.9 ft. in length.

The old line tracks swing farther to the north, cross Big Run and curve through a narrow rock cut which was originally Paw Paw Ridge Tunnel. This 250-ft. tunnel was through soft slate rock and was curved horizontally with a radius of 750 ft. It was of the same sectional dimensions with the Doe Gully Tunnel, was completely arched with brick and fronted with white sand stone. This tunnel was eliminated in 1905 by removing the top and thus forming the present day rock-walled cut. A few stone blocks may still be seen in place at either end of the original tunnel.

Continuing to descend on a 0.1 percent grade, the Cut-Off passes the southerly edge of the town of Paw Paw through a cut of considerable proportions. At a short distance west of Paw Paw the new line again parallels the old line tracks to the interlocking tower at Owonoko.

As the old line tracks were very close to the Potomac River west of Paw Paw where the river is very narrow, it was found necessary to construct a retaining wall 3,100 ft. in length along the riverside to avoid further hillside work. The grade of the new tracks being higher than that of the old, the old line was raised and shifted towards the river and, in conjunction with the new, forms a four-track railroad from the west end of Paw Paw Town Cut to Okonoko.

The four tracks then follow the long sweeping curve of the river, pass under the signal bridge containing the distance signals for NO interlocking and soon reach Little Cacapon Creek. At the mouth of this stream there are fine flats and a beautiful view of the mountains to the eastward. The stone viaduct over the creek is 143 ft. in length. From here the four tracks extend 1.2 miles to the switches at Okonoko Tower, and the west end of the Magnolia Cut-Off.

It may be of interest to describe briefly the geological conditions existing in the country through which this improvement is constructed. The Cut-Off lies entirely within what is known geologically as the Appalachian Valley, a region of parallel folds of comparatively moderate wave length. The rocks are all sedimentary and belong to the Davonian

Age, having a depth of 4,000 ft. to 4,800 ft. in the Jennings formation.

As noted on a topographic map, the topography is considerably broken up and consists of ridges running in a northeasterly and southwesterly direction, paralleling the Appalachian Range. The Potomac River is the only stream in this locality which cuts across these ridges; it flows through a narrow gorge-like valley and assumes considerable proportions during the period of winter and spring rains.

The tributary streams draining into the Potomac follow the valleys between the ridges and have small creeks running into them substantially at right angles. This "trellis" arrangement of drainage evidently results from the geologic transformation which took place in an early age and was probably caused by the upheaval of the earth's surface due to great pressure in a northeasterly and southwesterly direction which resulted in the formation of ridges at right angles thereto.

The formation represented in the local section, in which lies the Magnolia Cut-Off, is known as the Jennings, and consists of a buff sandy shale, platy gray shale, soft sandstone and thin conglomerate beds. The stratification of these rocks dips from 53 to 54 deg. east and the strike is about 34 deg. east of north.

From a map it is seen that the general direction of the Cut-Off work lies parallel to the strike of these rocks, and that because of this condition the easterly slopes of the cuts would expose the ends of the different strata. In general the beds were found to be of widely varying thicknesses and degrees of disintegration. They were fissured and checked very extensively and it was owing to this particular condition that great care had to be exercised in the excavation of the slopes on that part of the new line lying close to the old line tracks. Careful watch had to be kept at all times to see that none of these blocks of stone, made by the fissures and cracks vertical to the dip, would loosen unexpectedly and fall onto the tracks, and possibly having once loosened they might bring down a considerable area of stone above them.

In dressing the slopes care had to be exercised that no rock was left, a large proportion of which was not thoroughly embedded in the slopes.

Except in the tunnel approaches and in the large cut at Doe Gully, it is generally true that the slopes of the cut lie in the southeast quadrant on sidehill work.

Of course, the best exposure of these rocks was made by the Doe Gully Cut, which has a maximum depth of over 200 ft. Here the tunnel tangent lies almost parallel to the strike and on the west side the slope could be made to follow the stratification. Several unexpected conditions were found in this cut due to a decided change or crushing in the plane of the strata. In some cases this caused considerable difficulty in maintaining the slopes and in handling of the work in this unusually large cut. No indication of these conditions was evident on the approach cuts of the old tunnel or on the surface of the ground. After widening the cut and changing the rate of slope over the area covered by these changes in the beds of the rock, no more difficulty

was experienced and the slopes became practically self-supporting.

The hillside work west of Orleans Road presented no great difficulties other than caused by its closeness to the old main line tracks. The greater percent of the material was rock which was taken out in benches with about 8 ft. cuts. With the exception of such quantities that fell down the slopes and was carried across the tracks below, the material was wasted at the bench levels in the ravines of Rockwell Run and other streams.

Steam drills were used on this work together with one No. 40 and one No. 60 Marion steam shovel. On account of the nearness to the old tracks, it was necessary to use great care in blasting. A number of men were stationed at the foot of the slope in order to keep the operated tracks clear of loose stones which fell from the work above and to prevent the line from being blocked.

At a point about 6,000 ft. east of Doe Gully the new line was constructed with a 0.4 percent ascending westbound grade on a large embankment containing approximately 1,000,000 cu. yd. of material. This was possible on account of the large amount of excavation taken from the Doe Gully Cut which would have been entirely wasted had not this provision been made. At first two new tracks were laid on this fill and later two more tracks were added to replace the two old main line tracks along the hillside. The two old main line tracks were then abandoned.

While this new embankment does not reduce the curvature, it permits a curve of larger radius, having a 4 deg. curve instead of the 6 deg. curve on the old line. The construction of this embankment was carried out in the usual way, the material being dumped from temporary trestles.

At Doe Gully the double-track tunnel was replaced by a four-track open cut with a maximum depth on center line of 200 ft. and requiring the removal of approximately 1,400,000 cu. yd. of material.

The strata in Doe Gully Cut from surface indications before the work was started appeared to dip in an easterly direction at an angle of about 40 deg. It was planned to take out the west slope in three benches, the faces to coincide with the dip and the easterly face to be sloped one-half to one with two 25 ft. benches.

The grade of the new line was about 12 ft. below the old line tracks and on account of the necessity to keep the old double-track tunnel open for continuous service the material in the cut was excavated by steam shovels in the usual manner to within a short distance from the top of the tunnel; then the west side was excavated to grade, leaving a substantial shoulder over the tunnel. A small steam shovel was then put to work removing the remainder of the material above the tunnel, after which the tunnel was removed and excavation carried to grade, completing the cut for four tracks.

After good progress had been made the work was complicated by finding that the strata did not maintain the uniform dip indicated from surface conditions. Instead, they turned and twisted in a most

View looking east (down river) along the hillside toward Randolph Tunnel which can be seen in the distance. Along this part of the line the new grade is about 40 feet above the old line. The old line tracks pass through the tip of the ridge by means of Murray's Cut.

Viw looking west showing Kessler's Bridge on the new line and Kessler's Curve on the old line. Train is #23, the "West Virginian."

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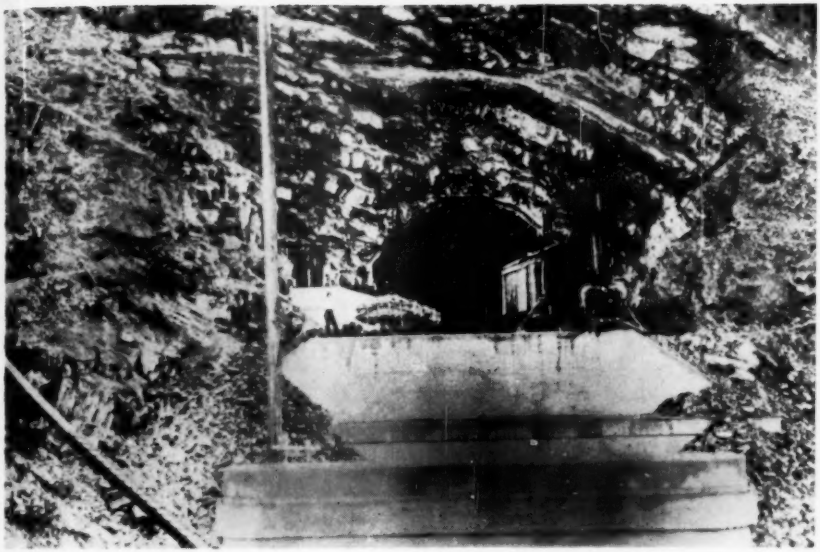


View showing the west portal of Graham Tunnel (August, 1914) before the completion of the concrete lining. This view gives a very good idea of the strata underlying this mountain.

Present day view from same location.

irregular way, being almost vertical in places, bent in others and presenting cracks, as a result of which part of the bench was lost. Over the old tunnel a seam of rotten rock was found and the work, which before was cautiously handled, was approached with redoubled care. To prevent a tie-up in case of accident to the old tunnel, the new grade was excavated alongside on a gentle slope from each end so that tracks could be laid and traffic taken care of with little delay. Tracks were laid on the new grade and traffic diverted until August (1914) when cracks developed and a large slide occurred, which made it necessary to take out the tracks and again put traffic through the tunnel.

One No. 40 Marion, three No. 60 Marion and one No. 73 Bucyrus steam shovels were operated in this cut.

The drilling was all done by air drills, using air at a pressure of 80 lb. for which a six-inch main was laid over the mountain and along the east side of the cut.

On account of the depth of the cut and loose character of the material, the slopes were benched at intervals of fifty feet vertically with gradients of 3 percent upper, 2 percent middle and 1.5 percent lower level. These benches were designed to afford drainage and prevent slides.

A short distance west of the old Doe Gully Tunnel location, the new line, instead of going around the toe of a ridge, cuts through the ridge by Randolph Tunnel which is 1,014 ft. in length, and on a 4 deg. curve to the south.

The same method of driving was used on all four tunnels, namely: a top heading about 9 ft. by 16 ft. was driven, followed by a No. 60 Marion shovel operated by compressed air which widened it to the full arch section. As the excavation progressed the rock was lined with timber, which was replaced with permanent concrete lining as soon as the shovel work was completed. The standard arch section (at that time), consisted of gravel concrete up to the 25 deg. line, above which point broken stone concrete was used, faced with one course of brick. The tunnel work on the Magnolia Cut-Off differed from the standard section, as broken stone concrete was used throughout. Every fifth brick was made a header to secure a bond with the concrete. It was found prior to the building of the Cut-Off that concrete lining in the tunnels was seriously affected by the gases from steam locomotives, causing rapid deterioration of the concrete. However, experience had shown that the standard tunnel lining as adopted, using 3 in. by 4 in. by 9 in. vitrified shale brick, had been very satisfactory and almost impervious to the action of locomotive gases.

There were 8,200 cu. yd. of concrete used in this tunnel lining, the mixture of which was one part cement, three parts sand and five parts broken stone. Various brands of portland cement were used, all of which were tested by the Baltimore and Ohio inspectors.

The four tunnels on this new line (named after past Chief Engineers of the B & O) all have 31 ft. horizontal sections providing for 14 ft. track centers. The arch has a radius of 15 ft. 6 in., the distance from the top

of rail to the keystone of arch is 24 ft. 6 in. and the minimum height above rail is 22 ft. 9 in. On account of handling very heavy Mallet locomotives (in use at the time the tunnels were constructed) over this division between the mountain grades of West Virginia and Pennsylvania and Mt. Clare Shops, Baltimore, it was necessary to construct all new tunnels with a maximum clearance.

As noted before, a very interesting section of the work extends along the hillside of Purslane Mountain about one and one-half miles in a southerly direction from Randolph Tunnel to Hansrote, W. Va.

Between these points the new line is located on a bench above and very close to the old main line tracks. On account of the danger to existing traffic, great care was used in prosecuting the work. Drills were used and most of the 400,000 cu. yd. of material was removed by steam shovels by excavating benches about 8 ft. in depth. The material was wasted in ravines at the different levels of the benches and a large quantity was placed on the river side of the old main line tracks. This permitted the old line tracks to be lined out to reduce the maximum degree of curvature from five to three degrees.

Leaving the old line tracks just west of Hansrote, the new line turns abruptly into Sideling Hill and crosses the divide through Stuart Tunnel, 3,355.4 ft. long, which is tangent for 2,973.8 ft. with a 381.6 ft., 2 deg. 30 min. curve to the south within the east portal. The east approach cut of this tunnel required the removal of over 200,000 cu. yd. of rock and about 90,000 cu. yd. of the same material were taken out of the west approach cut. Considerable difficulty was encountered in the west portal excavation on account of the almost vertical dip and badly broken strata.

The average heading section is about 120 sq. ft., but overbreaks developed, increasing this in one place to 185 sq. ft. The strata varies in dip from 45 deg. to considerably under this, the strike being approximately parallel to the center line.

The tunnel was driven from the west portal and from two shafts, 117 ft. and 40 ft. deep, respectively. The east approach cut was not completed in time to enable a heading to be driven from the east portal.

The headings were driven as usual, working from five points, and were widened to the full section by hand except for the first 1,000 ft. in from the west heading, where a small No. 40 Marion shovel operated by compressed air was used. With this shovel from 60 ft. to 70 ft. of arch were widened and timbered per week, as compared with about 45 ft. by hand. About 6 ft. of bench were taken out by the small shovel at the same time, thus securing ample working clearance. A large No. 60 Marion shovel, also operated by compressed air, was then used in removing the bench and small cars electrically driven were used for disposing of the material. Some difficulty was encountered in establishing the west portal and on account of the questionable character of the material at the east end, the heading from the center shaft was driven to within about 70 ft. of the east portal, at which point it opened into two wall plate drifts. The entire arch section was then removed for 30 ft., after which the wall plate drifts along were driven, leaving the

center support for the roof for about 40 ft. in from the portal until the portal was turned. At two places thin strata separated by clay were encountered, and falls occurred which delayed the work considerably.

Both timber and steel forms were used in the tunnel lining, there being over 2,200 ft. of the latter used in sections of the tunnel where unstable material was encountered. The metal arches proved to be a great improvement over the timber in that they reduced the tunnel excavation. They were not removed, the concrete being placed around them. This did away with some packing and increased the strength of the arch. I-beams, having a section of 15 lb. per ft. were used in this arching, being placed on 5 ft. to 7.5 ft. centers, depending on the character of material to be supported.

As the tunnel excavation progressed and the timber and steel forms were placed, they were followed up by the concrete lining, having dimensions according to the standard section. There were 26,600 cu. yd. of concrete used, mixed with a compressed air operated mixer in the proportion of one part cement, three parts sand and five parts broken stone. As this was the longest tunnel and presented the most difficulties in excavation, it was the last to have the lining completed.

The first Potomac River crossing is west of Stuart Tunnel at Magnolia, W. Va. It is about 1,000 ft. in length and consists of six 100 ft., three 80 ft. and two 75 ft. deck plate girder spans placed on concrete piers; the new grade is 50 ft. above the old line and about 80 ft. above low water. As noted elsewhere, this bridge from the east approach to Graham Tunnel, which is 1,592 ft. in length and passes through a ridge of Town Hill Mountain between the two river crossings.

The second Potomac River bridge is at Kessler's curve, immediately west of Graham Tunnel, and consists of four 100 ft. and six 75 ft. deck plate girder spans with three skew girder spans which are over the old main line tracks. The three skew spans have a combined length of 202.5 ft., making a total length of the bridge of 1,052.5 ft. Foot walks between tracks are provided, as well as refuge bays on each side to provide greater safety to track and bridge men. The 100 ft. girders have a depth of 9 ft., while the 80 ft. and 75 ft. girders have a depth of 8 ft. and 7 ft. respectively. The bridges at both river crossings have open floor spans except the two crossings over the old line tracks, where solid floors are used for protection against the gases of engines passing beneath on the old line.

The steel work was erected from the shore, without falsework, with a fifty-ton derrick car, which picked up the material from the low level and placed it in position, moving outward as the work progressed. The field riveting was done with compressed air. The structures were designed for E-60 loading, B. & O. R. R. specifications for material and workmanship. This permitted, with a large factor of safety, the heaviest engine and train loading in service at the time the bridges

were constructed. A total of about 3,000 tons of steel were placed, divided about equally between the two bridges.

The piers of both structures were founded on bed rock about 5 ft. below the river bottom. The cofferdams, made with plain sheathing and clay puddling, were placed on the bottom of the river and carried to the height of ordinary high water. The rock sub-strata lie near the surface at both crossings, so that the foundations did not present any difficulties and no floating plant was necessary. Ordinary wooden forms were used which were made in sections and handled by a derrick as the work progressed.

About 26,000 cu. yd. of concrete were required for piers and abutments, which was deposited mainly from towers located either on the bank or at the first river pier which could be reached by a derrick. The tower at Kessler's crossing was located near the west bank of the river and was 185 ft. in height. In the upper portion of a few of the piers above the reach of the tower, concrete was deposited by compressed air and two of the piers were completed by depositing concrete directly with a derrick.

Revolving mixers, one yard capacity, located on the banks of the river, were used in mixing the concrete, which was composed of one part cement, three parts sand and five parts broken stone. The major portion of the concrete was delivered to the towers by derricks and tramways, elevated and deposited into the various units through chutes.

The dimensions of the piers are 8 ft. by 35 ft. under the coping; the batter is ½ in. in 12 in. on all faces. The height of the grade line (top of rail) above low water is approximately 80 ft. Reinforcement consisted of ¾ in. round rods and 4 in. triangular mesh which was used in all piers above the footings. Vertical rods were placed near the face of the piers and horizontal rods were placed through the piers from side to side and from end to end in layers five feet apart.

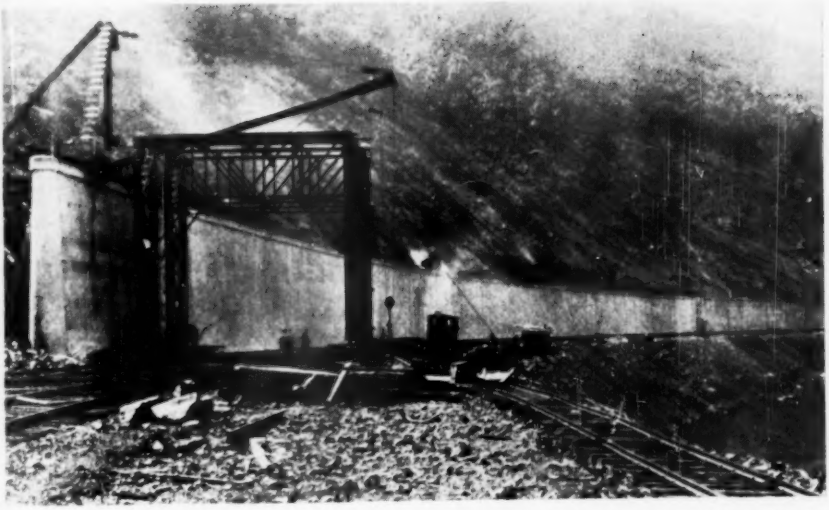
In five layers of horizontal rods placed parallel to the center line of the pier, the rods were spaced 24 in. center to center, and in the three corresponding layers of rods passing through the piers from end to end at right angles to the center line, the rods were spaced 12 in. center to center while in two layers a 24 in. spacing was used.

As noted, Graham Tunnel is 1,592 ft. in length and is located in the state of Maryland between the two Potomac River bridges. It differs from the Randolph and Stuart tunnels previously described, in that it is driven through stable rock instead of the loose, rapidly weathering material. It was driven by the same methods employed at the other tunnels, drills operated by compressed air and one No. 60 Marion shovel being used. Timber cribbing was placed as the excavation progressed, followed by the standard tunnel lining, using 12,700 cu. yd. of concrete of the mixture—one part cement, three parts sand and five parts broken stone. A revolving mixer operated by compressed air was used in mixing the concrete.

Beginning at Kessler's curve, the new line again follows in a southerly direction on a bench along the hillside about 40 ft. above and

View showing completed piers of Kessler's Bridge (July, 1914) looking east toward west portal of Graham Tunnel. The tower used to deposit the concrete for the piers can readily be seen in the view and the tracks of the old line can be seen in the foreground.

Present day view from the same location.



View looking west showing completed inter-track wall between Graham and Crothers Tunnels and the traveler (used to deposit the concrete) after it had been dismantled, July, 1914.

View looking east showing inter-track wall between Graham and Crothers Tunnels with west bound freight on Track #3.

paralleling the old line for a mile and one-half. Over 80,000 cu. yd. of rock were taken out along this bench at elevations varying from 40 ft. to 100 ft. above the old line tracks. On account of the hazardous nature of the work, it was handled by force account labor under about the same methods employed east of Hansrote. All of the sidehill cuts were benched in order to prevent slides and to reduce blockading the operated line to a minimum.

To reduce the sidehill excavation it was necessary to construct a retaining wall 1,800 ft. in length, located near the west end of the section. This wall is not reinforced and is of gravity section, having a maximum heighth above the footing of 31 ft. It is 2.5 ft. wide at the top and 15 ft. wide at the base. The elevation of the top of the footing was placed at 3 ft. below the top of the rail of the lower line. The construction of the footing caused considerable trouble and was extremely difficult at places where it was necessary to excavate to a maximum depth of 14 ft. below the top of footing in order to secure a firm foundation. At other points a 40 ft. rock face had to be moved to secure sufficient room. The top of the wall is 4 ft. above the elevation of the subgrade of the new line.

This inter-track wall is located between the old and new lines and required the placing of 22,000 cu. yd. of concrete. It was deposited by a movable traveler which spanned the two old line tracks and moved on two rails supported on timber blocking. This traveler, which proved very satisfactory, was constructed of steel and had a clearance of 32 ft. 9 in. horizontal and 23 ft. 3 in. vertical above the high rail on curves.

The traveler was equipped with two derricks having 50 ft. booms and two boilers and hoisting engines on the upper deck. In this way all of the excavating for the retaining wall footings and all the concrete was handled without interfering with the operated tracks and without any material being moved across the tracks at grade. The derrick located ahead on the platform handled all of the material excavated from the footings while the rear derrick deposited the concrete. The concrete mixing plant was located nearly one-half mile west from the work on account of insufficient room nearby and the material was carried to the traveler in small cars which were picked up and emptied into the forms. A cantilever projection from the traveler supported the wall forms which were of steel and their position relative to the traveler was regulated by turn-buckle adjustment in the vertical and horizontal supporting rods. As the forms were moved ahead from one section of the wall to the next, they were lifted free of the completed work. The wall was built in 50 ft. sections. The concrete mixture of one part cement, three parts sand and five parts broken stone was used.

With the necessary foundation excavation work and shifting and adjustment of traveler and forms, about two 50 ft. sections were completed per week. At the joint between each day's pouring a bond was secured to the adjacent rock face. The new roadbed was backfilled behind the wall as it was completed. About 4,000 cu. yd. of

concrete were placed per month by the traveler during the construction of the wall without interfering with the traffic, although the train movement was almost continuous at this point.

A short distance west of the inter-track wall the new line again diverges from the old line tracks and passes through a ridge of Spring Gap Mountain via Carothers Tunnel, which is 995.9 ft. in length and is located on a 2 deg. 30 min. curve to the south. The material excavated from this tunnel and the method of driving was similar to that of the other tunnels on the Cut-Off. One No. 60 Marion shovel and drills operated by compressed air were used.

Timber cribbing was placed as fast as the excavation progressed, and this was followed up by standard concrete lining, requiring 8,000 cu. yd. of concrete which was of the usual one-three-five mixture.

One of the largest cuts on the line is that along the southern edge of the town of Paw Paw, W. Va. The maximum depth on center line at this point is 96 ft. Over 500,000 cu. yd. of material were removed, the greater part of which was earth. It was hauled west about one and one-quarter miles to a point where the old line was raised about 7 ft. and shifted towards the Potomac River in order to make room for a four-track line without disturbing the rock hillside. This improvement, at the same time, places the grade of the old line tracks above high water.

With the exception of the Potomac River crossings at Magnolia and Kesslers, the only steel bridge on the line is an overhead highway structure crossing Paw Paw cut south of the town. There are two 12 ft. and two 8 ft. concrete arches on the line and several small openings. There are no highway crossings at grade.

A portion of the new fill, referred to above, extends to the river. In order to protect and at the same time without encroaching on the stream, another retaining wall similar to that east of Paw Paw was constructed. This wall is 3,100 ft. in length, has an average height of 24 ft., width at top of 2.5 ft., width at base of 15 ft. It required about 23,000 cu. yd. of concrete, which was mixed with a rotary mixer—one part cement, three parts sand and five parts broken stone. The wall being next to the river it was not necessary to span the operated tracks and only a wooden traveler was provided for shifting the forms. The concrete was deposited with a locomotive crane. The forms were of steel and built in 30 ft. sections, two sets were provided, which were used alternately.

To facilitate construction, the work on the Cut-Off was divided into eight sections, which were let to seven different contractors. The work on some of the sections was divided and sublet to contractors who had better equipment and probably more experience in handling the particular class of work required. The magnitude of the work required a large and thoroughly equipped contractor's plant. The equipment aggregated on the entire work consisted of the following pieces:

Shovels—Steam or Air		Number
Marion	No. 20	1
Marion Osgood	No. 40	1
Marion Osgood	No. 50	1
Marion	No. 60	17
Marion Osgood	No. 60	1
Bucyrus	No. 73	1
Total		22

Locomotives	
Size of cylinders 10″x16″ and 12″x18″	55
Locomotive cranes	2
Dump cars, about 4 cu. yd. capacity	550
Concrete plants, revolving mixers, 1 yd. capacity	6
Travelers spanning old line tracks for inter-track wall	1

Drills	
Air drills	64
Air jap drills	2
Steam drills	46
Steam jap drills	4
Total	116

Power Plants	
Magnolia	1
Doe Gully	1

On most of the sidehill work steam drills were used while air lines were installed for the tunnel work and Doe Gully Cut.

At Magnolia one power house was supplied with two compressors, each capable of compressing 1,644 cu. ft. of free air per minute, at 80 lb. pressure, to a 6 in. distributing pipe line about 11,500 ft. long. The other equipment consisted of six 100 h.p. boilers and two d.c. generators having a total capacity of about 200 kw. for lighting current at 250 volts. There were two sawmills and a forging and blacksmith shop of considerable capacity located at Magnolia.

The Doe Gully power plant consisted of four 100 h.p. boilers and two 75 h.p. boilers, two air compressors and one 50 kw. generator. The air compressors would compress 1,644 cu. ft. and 1,000 cu. ft. of free air per minute, respectively.

Suitable camps were provided to house laborers and other employees at Doe Gully, Hansrote, Magnolia, Kesslers and Paw Paw, particular attention being paid to sanitation and good quality of drinking water. Electric lights and modern fixtures were provided in the camps and on the work wherever possible to facilitate the work and add to the comfort of the employees. The total force employed was approximately 2,500 men.

The larger portion of the work being located adjacent to a busy railroad, where the traffic was almost continuous in each direction and in a mountainous country, it was necessary to take measures to prevent workmen from being struck by the trains. Foot paths were constructed on the outside of the operated tracks, either on the shoulder of the fill where the bank was too narrow, or on trestle construction. All employees were required to use these paths instead of walking on the tracks, and special instructions were printed which all employees were required to read and sign.

A policing system was organized by the railroad of uniformed and plain clothes men, who made it a special duty to see that the instructions were obeyed and to keep trespassers off the property.

Great care was taken also to protect traffic on the railroad; an operator was provided who was in constant communication with the dispatcher, and all blasting was done under strict control and inspection, 40 percent dynamite being used. No shots were fired without first learning the location of trains. Flagmen were also sent out in both directions in advance of each shot. Powder inspectors were provided to personally inspect the loading and firing of each shot so as to reduce to a minimum the danger of blockading the tracks below. Vigilance was the order of the day, and men with wheelbarrows were stationed at the foot of the slope under the steam shovels to remove the small pieces of rock which were impossible to keep from falling; these were carted to the riverside.

Very few fatalities occurred compared with tunnel construction work prior to the building of the Cut-Off, where the number of casualties had averaged one man for every 500 ft. driven. This however, was not the case at Magnolia.

Extremely few delays to trains occurred, which was one of the results of close supervision by the railroad employees in charge of the work and precautionary measures taken by the contractors.

The construction of the Magnolia Cut-Off completed a program of improvements on the Baltimore and Ohio which was authorized and started by President Willard in the early part of 1911. Most, if not all, of the various improvements were problems difficult to solve. Among these the Magnolia Cut-Off Improvement was the last, and undoubtedly the most difficult, and had been before the executive and operating officers of the Baltimore and Ohio since the turn of the century. The congestions in the vicinity of Magnolia, and principally on the Hansrote helping grade, had been a stumbling block to the operating officers for many years, the results of such congestions being far-reaching and frequently influencing the movement of coal out of the coal regions, as well as hindering the prompt dispatch of fast freight between distant cities. One may appreciate the relief felt by the management upon reaching the completion of this important work.

The Engineering Department was able to so regulate the progress of the work handled by each of the seven contractors that each closed out his section at about the same time and the entire work was completed

View showing west end of Paw Paw Cut located along the southerly edge of the town of Paw Paw, W. Va. Over 500,000 cu. yds. of material were removed from this cut to provide a maximum depth on center line of 96 feet.

View showing freight train on old line tracks opposite 3,100-ft. concrete retaining wall. Town of Paw Paw, W. Va., in background. Western Maryland's Hagerstown-Cumberland main line tracks may be seen on the Maryland side of the river.

as a unit; this being considered quite an achievement. The Improvement work was carried on with such progress that it was completed three weeks earlier than the originally estimated time, eastbound freight trains being operated over the new line by the first of December, 1914. The cost of the work was also less than estimated, the total expenditure being approximately $200,000 less than the total estimate of $6,000,000. At several points it was possible to make connections with the old line which enabled the construction of tracks as fast as the grading was completed so that near the completion of the work it remained only to connect the various sections in order to get a continuous track over the new line. The entire work from the standpoints of cost, hindrance to traffic and time of completion was successfully carried out, and to the satisfaction of the management.

The Old Class HA Locomotives of the Central Pacific

By David L. Joslyn

In the Fall of 1880, General Master Mechanic (now known as Supt. of Motive Power) A. J. Stevens called his Chief Draftsman, George Stoddard, into his office and explained to him that a type of motive power was required for the Oakland local service. He said that the small 8-wheel engines, such as the "T. D. Judah" and several other small and odd locomotives handling the traffic on the locals were not capable of giving the service required; business was increasing and traffic had to be speeded up.

The 8-wheel locomotives were doing pretty well, but operated head-end first, from the ferry terminal to the end of the line, where they coupled on to the other end of the train and backed up to the Oakland terminal.

"What is needed," said Stevens, "is a locomotive that will be powerful enough to handle the traffic; one that will be flexible enough to take the sharp curves at fairly high speed; one that can start and pick up speed rapidly; and one that can operate in either direction without having to be turned." Stevens submitted a pencil sketch, rudely drawn, of a possible type of locomotive, and a sketch of a set of valves for the engine, that would admit steam quickly, and just as quickly let the exhaust out of the cylinders, thereby reducing back-pressure to a minimum. "So, Mr. Stoddard, I suggest that you get right after this at an early moment," added Stevens.

Stoddard started at once and, in a few days, submitted plans for a locomotive with 2-6-2 wheel arrangement, with water tanks alongside of the boiler and extending back under and behind the cab, and having a combined capacity of 1600 gallons. Coal space of four tons capacity was provided behind the cab. This would give ample water for a round trip from the ferry terminal to the end of the line and return, and enough coal for several trips.

Cylinders were to be 16″ dia. by 24″ stroke, drivers to be 51″ dia., and ample boiler capacity of 135 lbs. steam pressure was indicated. Steam chest valves were of a new type, whereby each end of the cylinders had its own valve for admitting steam directly into the steam ports of the cylinder, but operating as one unit, and designed along the lines suggested by Stevens. The rigid wheelbase was short, the total wheelbase being kept as short as possible, and a new type of swivelling front and back truck was designed.

Mr. Stevens approved the design and Stoddard, with the assistance of his one draftsman, Chas. T. Noyes, started at once to get out the necessary working drawings and details. By early 1881, the shops had started on making the different parts. All parts were made in the company shops, except steel tires for the driving wheels, steam gauges,

headlights, boiler flues, injectors and water gauge glasses. In keeping with the common standard practice of the shops, the frames were hammered out of scrap iron tied in bundles, and the pieces welded together to form the two pieces of frames, each side being in two lengths, the fitted parts being planed smooth and joined with turned bolts.

While coal was to be the fuel, the engines were equipped with the C. P. standard diamond stacks, made from 3/16″ steel plates riveted together and fitted inside with the cast iron deflector and water wheel cone that whirled the sparks and cast them downward. The middle pair of drive wheels had blind tires. Cylinders were cast in three pieces, the center part fitted to the boiler front, and each cylinder bolted to the center piece and to the frame.

An ingenious foot brake was fitted to the back two pairs of drivers and, briefly, consisted of the following. On each side in the cab, within easy reach of the engineman, was a foot lever attached to a fulcrum, which in turn was connected to a bellcrank and a series of levers, exerting high braking power on the brakeshoes when the engineer and fireman pushed down on the foot lever. As passenger cars on the locals were fitted with hand brakes, for brakemen to operate as a train came into a station, foot brakes on the engine helped to stop the train quickly. These foot brakes were soon replaced with Central Pacific push-down type air brakes made at the shops, and acting on the two pairs of rear drivers only. Later on the engines were equipped with the American Brake Co. (Westinghouse) type of brakes, acting on all three pairs of driving wheels.

When built, the engines had Mason type bells and bell stands, which were cast at the shops, utilizing an old Mason bell and stand as patterns. Sandboxes were placed on the boiler top, at the rear of the stack, and the bell was placed between the sandbox and steamdome. This was found to be a poor arrangement as sand could be used only in front of and behind the front drivers. So, sandbox and bell exchanged places and then, with air-operated sanding device of C. P. design, sand was distributed in front of the forward drivers and in back of the rear drivers.

The first of these locomotives was turned out of the Sacramento shops, in December, 1881, and the remaining six were turned out in 1882. They operated well and took care of the Oakland local trains in fine shape.

Sometime in the early '90's, new fireboxes were required, and new front flue sheets were also applied. When this was done, the front end of the smokebox was extended and straight stacks were applied. About 1902, the locomotives were fitted to burn crude oil, and a tank of 800 gals. capacity was then fitted into the coal space. About this time, some of the engines were fitted with steel running-boards and steel cabs, in place of the old wooden ones.

The seven locomotives gave efficient service until the local lines were electrified. Then the little Oakland local engines were set out back of the roundhouse with a number of other small engines. Cabs were

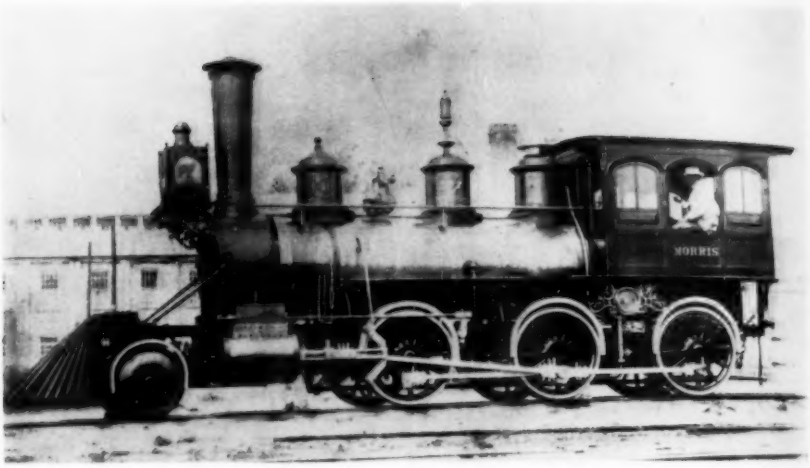
boarded up, and the engines sat out there for a long time, gathering rust and looking very forlorn. Later, they were brought to Sacramento, given some repairs and put up for sale. They disappeared from Sacramento, their disposition as shown herewith having been taken from notes in a classification book.

1st No.	2nd No.	3rd No.	
230	1501	1900	Shop switcher at Sparks, 6-16-18, broken up in 1936.
231	1502	1901	Shop switcher at Ogden, 6-10-16, broken up in 1947.
232	1503	1902	Sold to N. B. Livermore, June, 1912.
233	1504	1903	Sold to logging company, August, 1914.
234	1505	1904	Sold to Shattuck and Edinger, 1912.
235	1506	1905	Sold to Tidewater Southern R. R., 1912.
236	1507	1906	Shop switcher at Brooklyn shops.

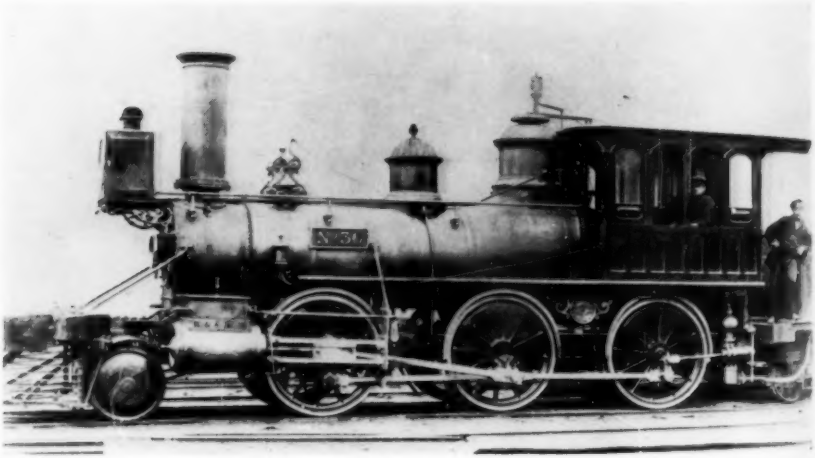
Looking at a picture of these engines as built, one is inclined to think they had the A. J. Stevens valves and gear, wherein the valves were separate for each end of the cylinder, because the steam chest was nearly as long as the cylinder. However, the valve gear was the conventional, Stephenson double-eccentric, sliding link gear. As explained before, the valves were operated as one unit, with a long valve yoke inside the steam chest. The first valves were of the C. P. gridiron pattern, later ones were of the American balanced valve type, but of C. P. make.

Dimensions of old class HA, new class S-1.

Cylinders	16″ dia.
Cylinders	24″ stroke
Drivers	51″ dia.
Steam Pressure	135 lbs.
Steam ports	1″x12″
Exhaust ports	2¾″x12″
Outside lap of valves	¾″
Inside lap of valves	⅛″
Heating surface of firebox	87.4 sq. ft.
Heating surface of flues	777.0 sq. ft.
Rigid wheel base	14′ 0″
Total wheel base	28′ 0″
Weight on drivers	80,100 lbs.
Weight of locomotive loaded	103,000 lbs.
Safety valves, C. P. Spring Pop style, 2¼″, set at 135 and 140 lbs.	Two valves
Fuel	Coal
Capacity of fuel	4 tons
Capacity of water tanks combined	1600 gals.
Grate area	14.68 sq. ft.
Heating surface per sq. ft. cylinder	2.32



C. R. R. of N. J. #40. New Jersey L. & M. Co., 1862.



#36 New Jersey R. R. & T. Co. Rogers' Mogul of 1863.

The Early Moguls

By Stewart Graham

There seems to be controversy as to the FIRST locomotive of many of the standard wheel arrangements. Those of the 4-4-0, 4-6-0 and 2-8-0 types are pretty well established, but there is a diversity of opinion regarding some of the others, viz., the Atlantic, the Pacific, the Mikado, and the Prairie types.

For many years it has been stated, without being refuted, that the first true Mogul, or 2-6-0, type was built for the New Jersey R. R. & Transportation Co., by Rogers Locomotive & Machine Co., in 1863. This wheel arrangement had been used prior to this time, notably on the "Pawnee" class of the Philadelphia & Reading, built by that company in 1852, and the engine "Anthracite" of the D. L. & W., built by Danforth, Cooke & Co., in 1854, but in these cases the pony truck was placed to the rear of the cylinders, and was held rigidly in the main frames.

Angus Sinclair, in *Locomotive Engineering*, June, 1897, indicated that the first Mogul was built by the Baldwin Locomotive Works, in 1867, for the Thomas Iron Co. This engine bore shop number 1630, and was completed May 25th, 1867, being numbered 4, and named "E. A. Douglas." Its cylinders were 16″x22″, diameter of drivers, 44″, and its total weight was 27½ tons.

Almost without exception, locomotive historians have credited the N. J. R. R. & T. Co. engines with being the first of the Mogul type. This idea may have been fostered by claims of the Rogers Company itself, because of the extreme popularity of the Mogul, and its almost universal adoption for freight service, in which, for many years, it all but replaced the 4-4-0 and 4-6-0 types.

It is very evident, however, that many of the writers on locomotive development have overlooked two engines of this wheel arrangement built in 1861 and 1862, by the New Jersey Locomotive & Machine Co., for the Central R. R. of New Jersey. The first of these was No. 34, "Passaic," the other was No. 40 "Morris," both built for six-foot gauge track, for handling coal trains received from the D. L. & W., at Hampton, N. J., for transshipment to Elizabethport. These two engines were either scrapped or sold in 1876.

Were these the first "true" Moguls, or was Bissell's patented truck, which made possible the 2-6-0 wheel arrangement, and which was available as early as 1858, applied to locomotives prior to this time?

Chicago, Burlington & Quincy Railroad

Transition From Wood to Coal Burning Locomotives

By A. W. Newton

The history of locomotives on the Burlington, during its early years of operation, is not unlike the history of development of motive power on the great rail transportation system of the United States, then building. Its first locomotives were the 4-2-0 and 4-4-0 types, the first used on American Railroads.

From 1850 to 1856 all power purchased was wood burning, although coal for fuel was being used to a certain extent on Eastern Roads prior to 1850. The use of coal for fuel, however, was not fully developed until the late fifties.

In 1857, the railroads of the United States sent two prominent engineers to England and the Continent (Messrs. Colburn and Holley) to study, together with other practices of railroads, the coal consuming locomotives in those countries with a view to improvement of coal combustion in American locomotives.

In the meantime, mechanical engineers of this country, together with locomotive builders, were active in developing improvements that were better adapted to the burning of available coal, both anthracite and bituminous.

The use of wood burning engines on the Burlington during the early years of its existence, was largely due to the availability of that fuel. Coal, at that time, must be brought long distances and the transportation charges high, making its use almost prohibitive, at least uneconomical.

In 1855, after the road had been completed as far as Galesburg, the officials began to plan for use of coal for between Mendota and Galesburg the line passed through a territory where coal existed and was being produced in quantities only limited by demand.

Wood consumption was high, necessitating fuel yards at every station, and frequently at intermediate points. The cost of wood, due to depletion of timber adjacent to the railroad, was gradually increasing, and it was but a question of time until sources of supply would be exhausted.

Furthermore, even in the undeveloped state of coal burning engines, they were proving more economical than wood burners, and it was but natural that the officers of the Company should now be considering a change from wood to coal.

In 1855, an order was placed with the Manchester Locomotive Works, by the Central Military Tract Railroad, for a coal burning engine which was delivered about January 1, 1856, just a short time before the consolidation of that road with the Burlington (July 9, 1856). In the annual report to stockholders (the last one made by that road) for the year ending April 30, 1856, the president, James F. Joy, stated:

"There has been one of this kind (coal burner) of locomotive upon the road, in common and every day use, now for nearly three months, and we are happy to say that the experiment, so far as we are able to judge, is perfectly successful. The coal used is the Bituminous coal of the country through which the road runs."

With "the experiment" underway but three months, the results were so satisfactory that the president further stated:

"Four more first class locomotives for freight have been contracted for, constructed for the purpose of burning coal instead of wood for fuel," . . .

and at the same time conversion of wood burning engines was being made at the Company's Shops, because as he said:

"There will be no difficulty (so simple is the construction) in converting all the engines on the road into coal burning machines."

In the annual report to Stockholders for the year ending April 30, 1857, the president said:

"The directors take special pleasure in announcing the success of their efforts to procure a locomotive adapted to the burning of coal of Illinois. It is now some more than a year since they had a coal burning locomotive constructed at the Manchester Works (Manchester Locomotive Works); it has been in constant use for the whole year, doing service equal to that of any wood burning locomotive."

That progress was being made in changing to use of coal for fuel is shown in this report which says:— "The company has now running upon the road *eleven* engines of this description" at which time there were only 54 locomotives on the road.

And finally the report says:

"The use of it (coal) successfully for fuel, which now seems beyond question, is a matter of great importance to the future prosperity of the road."

The following year, the annual report shows seventeen coal burners of a total of 58 locomotives on the road.

On April 30, 1867, the annual report shows only four wood burning locomotives of a total of 119 and these disappeared the following year.

With engines constructed wholly of wrought iron, so far as the fire boxes, flues and boilers are concerned, it was but a short time until the corrosive elements, so dominant in the coal obtained along the line, began to affect locomotive fireboxes.

In the report for April 30, 1852, it was stated that

"copper is the only material that will endure in our fireboxes. Recent examinations prove that after *three years* service it is uninjured, while iron will not last an average of *eighteen months.*"

At that time, such was the case for it was not until commercial production of Bessemer Steel, about 1867, that a metal was available with properties that would resist the rapid deterioration of wrought iron occasioned by the sulphur elements in coal. Even with steel then available, the use of copper continued for a number of years, but in gradually decreasing quantity, because of its cost.

The economy of using coal for fuel was a question of immediate study after the purchase of the first coal burners. In 1858, two years after the use of coal began, the president advised the stockholders that the saving on coal over wood (for fuel) had that year amounted to 47% and "That on freight locomotives, coal cost per engine mile amounted to 10.16c, while for wood, the cost was 19.07c."

June 20, 1862, the General Superintendent, Mr. C. G. Hammond, of the road, speaking of comparative performances of freight engines, using different grades of Bituminous Coal, from Illinois and Missouri said

> "The latter is as good a bituminous coal as comes to this market, but still not considered equal to the best of Pittsburgh or Ohio River coal. This trial has satisfied us that, with the same grades and curvature, same coal and water, and other circumstances equal, our coal engines cannot be excelled by any coal burners in use. The impure coals of Illinois cannot be economically burned in any less perfect combustion chamber than we use."

At this time, Mr. C. E. Jauriet was Master Mechanic of the road, and had developed a "watertable fire box" and a patent "smoke stack" that added greatly to coal combustion efficiency.

During the month of June, 1861, a test was conducted by him on six locomotives of the Company—these were engines numbered 39, 40, 45, 53, 54 and 59. The test showed that 70 lb. of Illinois Coal was consumed per engine mile, while Missouri Coal was consumed at but 44.1 lbs. The miles run per ton of coal were, Illinois—28.5 and Missouri—45.38. However, the cost per engine mile was 9.32c for Illinois and 11.57c for Missouri because the cost of Illinois coal in tender was $2.20 per ton, while the cost of Missouri coal was $4.44, over double that of Illinois.

The Hannibal and St. Joseph Railroad, destined later to become a part of the Burlington System, had just been built through the extensive coal fields lying east of Brookfield, Missouri. It was still an independent company and its rates on coal to Hannibal for delivery by boat transfer to the Burlington at Quincy, accounts for the disparity in coal cost on tender, as above stated.

These facts prompted the statement made by General Superintendent Hammond in 1862, that "we must continue to use Illinois coal and larger quantity per mile run, than would be required if the cost of transportation of foreign coal did not forbid its use."

It was not until several years had passed that the use of this inferior coal could be supplanted with better fuel from other fields.

The first recorded list of engines of the Burlington was printed in the annual report of that road as of May 1, 1858. An analysis of that report follows in an attempt to allocate the 58 units shown in it, to the various roads that had previously been consolidated into what was on that date the Chicago, Burlington and Quincy *Rail Road* Company.

The Steam Locomotives of the Pennsylvania Railroad System

Part III

By Charles E. Fsher

In the two previous articles we have traced the growth and development of the locomotives of this railroad up to the turn of the present century. This article will bring the series to its conclusion.

In 1896, the West Jersey & Seashore R. R. was formed by the consolidation of the West Jersey and Camden & Atlantic Railroads. Atlantic City and the South Jersey beach resorts were cool havens to escape the summer heat of the seaboard cities and an improvement in the physical condition of both properties resulted in faster and better service between Camden, opposite Philadelphia and Atlantic City. The Philadelphia & Reading R. R., by means of its controlled Atlantic City R. R., was a worthy competitor in this service. In 1898, the 58.3 miles between these two cities was covered in 55 minutes. Add to the above the fact that the ferries were sometimes delayed, resulting in the train being a few minutes late in starting, the promise of an exceptionally fast run was frequently fulfilled. The road was almost level and free from curves after leaving either terminal.

The D-16a class inaugurated this service and, under favorable conditions and not too heavily loaded, could make the time. The road became aware that larger locomotives were needed and the use of the Atlantic type on the Atlantic City R. R. (Philadelphia & Reading), from the Baldwin Works, paved the way for the first of this type on the Pennsylvania. These locomotives have already been described by our member, Mr. Paul T. Warner in his article on the Atlantic Type Locomotive in our Bulletin 62. The boiler was of the Belpaire type with wide firebox placed back of the driving wheels and above the trailers. It had 68 square feet of grate area and a combustion chamber 39 inches long, separated from the firebox by a brick bridge wall, extended forward into the boiler barrel. These engines proved to be exceptionally free steamers. Cylinders and machinery details had many features in common with the H-5, H-6 and D-16 classes. The cylinders were cast separately from the saddle and all steam and exhaust passages were ample and free from abrupt bends. The guides were similar to those on the D-16 and the main and side rods had thin webs and flanges and were of minimum weight for the required strength. American balanced slide valves were used with an outside steam lap of 1½ inches and a valve travel of seven inches. This long travel was obtained by prolonging the upper end of the link to add several extra notches to the quadrant thus permitting a cut-off of 83 per cent in full forward gear which permitted greater power in starting and accelerating the trains. Juniata No. 585, P. R. R. No. 698, 5/1899 was the first of three engines of this class, E-1, to be built.

These locomotives turned in a wonderful performance and with trains of 300 tons could easily make 75 miles an hour between Hammonton and Drawbridge, a distance of 27.4 miles. The management objected to the separation of the engineman and fireman and several experiments were made by blocking off portions of the grates. A revised design was prepared and Juniata No. 700, P. R. R. No. 269, 7/1900 was the first and only one built. Originally designated as Class E-2, the classification was subsequently changed to E-1a. All of these locomotives were designed by Mr. Vogt and they showed thought and care in design and skill in their construction.

In 1901 the design was further improved in the class E-2 locomotive. These were generally similar to the E-1a but the grates were six inches wider and a larger number of tubes were used. The heating surface was increased from 2,429 to 2,640 square inches. Fireboxes of both classes were rigidly stayed but the pressure was increased from 185 to 205 pounds. Instead of rigid trailing wheels, a radial truck was used and the tender, instead of being mounted on six wheels was carried by the regulation two four-wheel trucks. The road went back to having only one dome mounted on top of the boiler as in the old D-7 and subsequent classes and these engines were exceedingly trim and handsome in their appearance.

These E-2 engines turned in a good performance not only on the Camden-Atlantic City runs but on the New York and Philadelphia Divisions as well. For service on the Pittsburgh Division, the Class E-3 was designed, the only difference was an increase in the diameter of the cylinders from 20½ to 22 inches. In 1902 the design was again changed to include Belpaire boilers and these were classed E-2a and E-3a respectively. Improvement in the tracks and bridges made it possible for the road to carry 60,000 pounds on each pair of drivers, while on some roads, at this time, a locomotive with three pairs of drivers would have to have been designed to do the same work.

The first locomotives of these classes appeared in the following order:

Juniata No. 776, W. J. & S. No. 65, 5/1901, Class E-2
Juniata No. 833, P. R. R. No. 621, 10/1901, Class E-3
Juniata No. 907, P. R. R. No. 2024, 6/1902, Class E-3a
Juniata No. 908, P. Ft. W. & C. No. 166, 6/1902, Class E-2a

On the Lines West, the Atlantic type locomotive had certain classes not found on the lines east of Pittsburgh. In 1903, the American Locomotive Co. delivered thirty-two locomotives of this type to the Lines West. The first nine, delivered in March of that year, were equipped with piston valves, first to be so equipped save for the single D-15 locomotive. The valves were placed under the smoke box in line with the cylinders. The cylinders were cast with one half the saddle and held together with seven 1¼ inch bolts. The balance of the order, twenty-three locomotives, were equipped with the Richardson slide valves. At the time of their construction, these locomotives were classed as E-2a but they were subsequently classified as E-2b and E-2c

respectively. On all of the Atlantic type locomotives that had been built to date, it had been the standard practice to have the center line of the stack 5¼ inches ahead of the center line of the cylinders. On the E-2b and E-2c classes, these center lines coincided.

That this type of locomotive could travel at high speeds, there seems to be no question. One of them, probably an E-2b, handled a party of officials on a special train between Pittsburg and Cresline, non-stop, making the 189 miles in four hours, lacking one minute. Then, it was on June 12, 1905, that Penna. Lines No. 7002, class E-2, hauled the "Pennsylvania Special," now the "Broadway Limited" between Crestline and Fort Wayne, 131.4 miles at an average speed of over 68 miles an hour. The three miles between AY tower and Elida were covered in 85 seconds at the rate of 127.1 miles an hour.

The final development in these two major classes came with the application of the Walschaerts valve gear in 1906 and they were classed as E-2d and E-3d respectively.

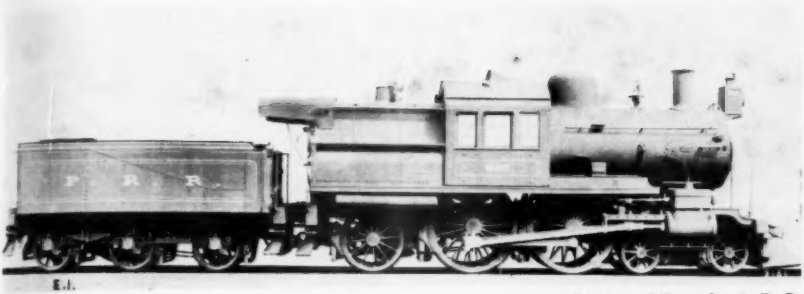
Mr. W. W. Atterbury, later to become president of the road, had served as Superintendent of Motive Power of the lines east of Pittsburgh from October 1, 1901 to January 1, 1903. He was succeeded in turn by Mr. Alfred W. Gibbs, a man that was universally liked and respected by all those who served under him or came in contact with him.

On June 15th, 1902, the road placed in service between New York and Chicago an all-Pullman train called the "Pennsylvania Special." It was timed to make the run in twenty hours. Starting out with a consist usually of four cars, it was handled generally, over the level portions at least, by locomotives of the D-16 class and the train maintained a fine record of punctuality. Because of the freight congestion, the train was withdrawn on February 1, 1903.

In 1904, at the Louisiana Purchase Exposition at St. Louis, the Pennsylvania R. R. installed in the Transportation Building, a locomotive testing plant as part of its exhibit. Here, on this plant, locomotives of several roads were tested and the results were made public in a bound volume. The plant was subsequently moved to Altoona, housed in a special building designed for that purpose and the results of these tests have been of inestimable value.

Among the locomotives tested at St. Louis was a balanced compound of the de Glehn type, built in France and purchased by the road for experimental purposes. Of the Atlantic (4-4-2) type, equipped with Walschaerts valve gear, it represented a high standard of design and workmanship. Valuable results were obtained from these tests but the locomotive lacked the necessary capacity to handle the heavy trains. During the last, the No. 2512, stood outside the office of the Master Mechanic at Altoona, Mr. J. C. Mengel, where she was known as "Mengel's paperweight." She was withdrawn from service in 1912.

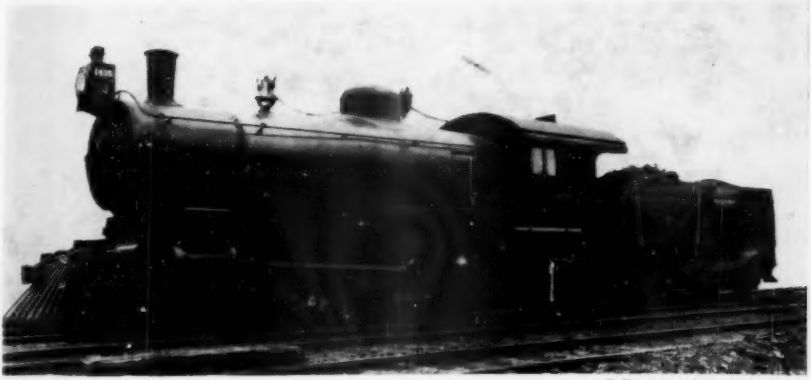
In 1905, the road purchased two balanced compounds from the Baldwin Works and two compounds from the American Locomotive Co., classes E-28 and E-29 respectively. One engine of each class was assigned the Lines West and the lines east of Pittsburgh. The design



E.L.

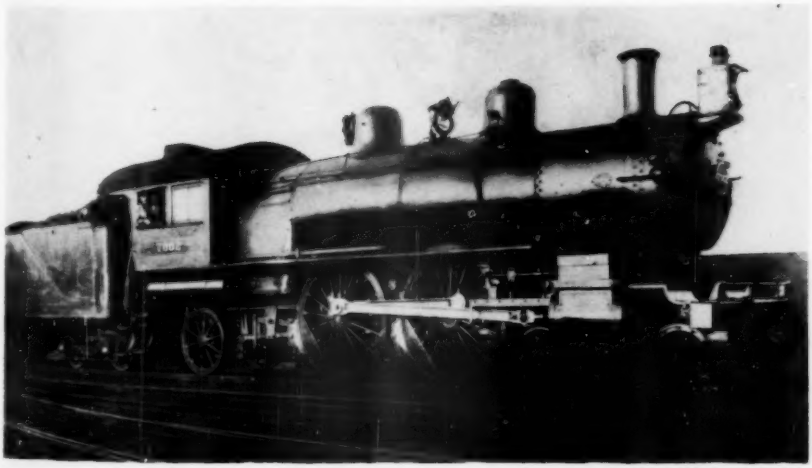
Courtesy of Pennsylvania R. R.

P. R. R. #820. Juniata Shops June, 1899. Class E-1.



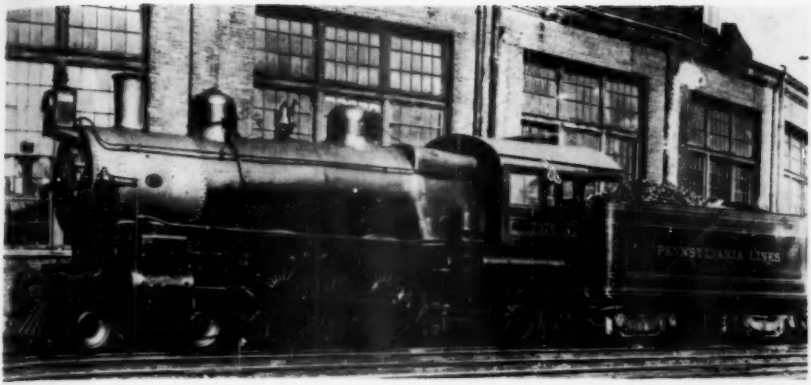
Collection of R. & L. H. S.

P. R. R. #1435. Juniata Shops, Nov. 1901. Class E-2.



Courtesy of Dr. E. B. Pedlow

Pa. L. #7002, Juniata March 1902, Class E-2. The engine that made the fast run on the "Pennsylvania Special" —Jerry McCarthy in the cab.

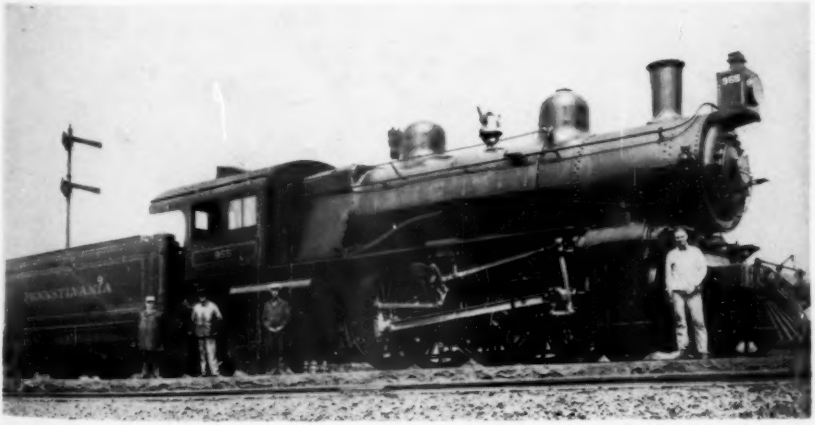


Courtesy of Robert C. Schmid

Pa. L. #7376 at Fort Wayne, Ind., 1911. A. L. Co. 1903, Class E-2c (first)

Collection of R. & L. H. S.

P. R. R. #2024. Juniata Shops July, 1902. Class E-3a.



Collection of R. & L. H. S.

P. R. R. #955 and crew. Juniata Shops May 1908. Class E-3sd.

of these locomotives was based on the E-3a class, the high pressure cylinders were connected with the No. 1 pair of drivers and the outside cylinders had the main rod connected with the second pair of drivers. A single line beam simplified the spring rigging between the rear drivers and trailers and this arrangement was subsequently used on several future classes built at Altoona. Two more experimental engines were received the same year of the Prairie (2-6-2) type. Both were built by the American Locomotive Co. and the design was based on the J-41 class of the Lake Shore & Michigan Southern Ry. These engines had 21½x28″ cylinders, 80″ drivers and weighed 233,500 pounds. Both had radial stay type boilers but the locomotive assigned to the P. R. R. had the Walschaerts valve gear while the one on the Lines West used the Stephenson. What trains these locomotives handled, we have no way of knowing at this late day. Pictures show the No. 2768, class J-28, 2-6-2 type, handling the "Manhattan Ltd." near the "Zoo" tower in Philadelphia. One of our members whose home was in Ft. Wayne recalls that from 1910 to 1913, the No. 7452, her "sister" on the Lines West, handled a heavy local passenger train between that point and Chicago with remarkable punctuality. The boilers of the Prairie type locomotives were 73 inches in diameter, larger than anything on the P. R. R. at that time and I can't help but feel that they influenced Mr. Gibbs in the use of larger boilers on his locomotives. None of these classes, E-28, E-29 and J-28 were repeated.

Let us turn our attention for a moment to the freight locomotives. The class H-6 "consolidations," with their long fireboxes were difficult to fire and the success of the wide firebox used on the passenger locomotives led the motive power department to order the first H-6a from the Baldwin Works, P. R. R. No. 1890, BLW No. 19071, 5/1901 being the first one delivered. On these engines the firebox was placed over the rear drivers and the grate area increased 47% with the length of the firebox reduced from 120 to 107 inches. In 1905 the design was further improved by the application of the Walschaerts valve gear, Class H-6b. These two classes were not only built at Altoona but by the Baldwin and American Locomotive Companies and there must have been nearly two thousand locomotives of these two classes built and distributed throughout the system. They were neatly proportioned, simple in design and they turned in a good performance.

In 1901, the class F-1, Mogul, was improved with a larger boiler and higher steam pressure. P. R. R. No. 446, Class F-3, built by Baldwin, construction No. 18945, 4/1901, was the first one delivered. Two sub-classes based on this design followed, the F-3b with a wide firebox, radially stayed boiler and the F-3c with a wide firebox and Belpaire boiler. All had slide valves, Stephenson valve motion and were assigned the eastern portion of the road where the grades were easier.

In connection with the six experimental passenger engines delivered in 1905, there were two consolidations, H-28 class, one built for the Lines West, the other for the P. R. R. These locomotives had a 23x32″ cylinder, 63″ drivers and weighed 221,500 pounds. They had wide fireboxes, radial stayed boilers and Stephenson valve gear and were very

much like the G-5 class on the New York Central. The boiler diameter was 80 inches, which was quite an increase from the 69½ inches on the H-6. One of these engines, Pa. Lines No. 7748, was subsequently sold to the Toronto, Hamilton & Buffalo where it took road No. 60. She was sold to the Cincinnati, Indianapolis & Western as the No. 331 and when that road was acquired by the Baltimore & Ohio she became their No. 439. Altho' the P. R. R. never repeated any of these designs, they probably played a part in the design of the coming H-8 class.

The "Pennsylvania Special" which had been withdrawn from service in 1903 was restored as an eighteen hour train between New York and Chicago on June 11, 1905. This called for an average speed, including stops, of 50.2 miles an hour and the 189 miles between Jersey City and Harrisburg was made in 196 minutes at an average speed of 57.8 miles an hour with one stop at North Philadelphia. There was some confusion between this train and the older "Pennsylvania Limited" and, coincident with the change in name, on November 24, 1912, the "Broadway Limited" came into being with a twenty hour schedule. During the heavy traffic conditions of World War I, the train was withdrawn from service on December 1, 1917 and restored to its twenty hour schedule on May 25th, 1919. At present it is operating on a sixteen hour schedule and is one of the most popular trains on the system.

In 1906, the motive power department faced a new problem for their passenger locomotives. Work on the construction of the new terminal in New York City was well underway. The road very wisely adopted the policy at the outset of allowing only steel equipment to be used in the tubes under the North and East Rivers. This meant that all passenger equipment, including Pullmans, must be of steel construction, not only for the main line trains but those from Washington and Philadelphia as well. This meant more powerful locomotives. Already, there had been considerable double-heading of trains between Pittsburgh and Chicago on the P. Ft. W. & C. Ry., and, in 1907, the Pittsburgh Works of the American Locomotive Co., delivered Pa. Lines No. 7067, the first Pacific type to be used on the system. With its 24x26″ cylinders, 80″ drivers and weight of 273,600 pounds, this locomotive represented the best in that type built to date. The weight carried on each pair of drivers averaged slightly better than 60,000 pounds and the locomotive had a tractive effort of 32,620 pounds. With a wide firebox, radially stayed boiler, this locomotive in actual service handled trains of twelve or more (wooden) cars over an undulating profile and demonstrated that it could do it successfully.

Following the results of this experimental locomotive, designs for a Pacific type were prepared both by Altoona and Fort Wayne and the designs of the latter were accepted. Juniata No. 1983, Pa. Lines No. 7510, 1/1910, was the first K-2 built on a design that closely followed the experimental locomotive (K-28) but with a Belpaire boiler to conform to P. R. R. standard.

Juniata No. 2011, P. R. R. No. 1750, class E-5, 3/1910 was the first of about a dozen locomotives built of this class. These were based on the E-3 design but they carried more weight on the drivers and

weighed more than the engines of that class. Five were assigned the Erie Division, the balance were assigned to the roads under P. R. R. control.

Before continuing further with the passenger locomotives, let us turn for a moment to the more prosaic types. In 1902, an 0-6-0 (B-6) switcher made its appearance and Juniata No. 942, Pennsylvania Lines No. 8026, 10/1902 was the first one built. These engines had 22x24″ cylinders, 56″ drivers and weighed 169,000 lbs. In 1911 the design was modified and class B-6a was brought out. A smaller switcher of this same type was built in 1904 and Juniata No. 1162, P. R. R. No. 44, 5/1904 was the first B-8 class to be built. These engines had 20x24″ cylinders, 56″ drivers and weighed 143,450 lbs. In 1903, the American Locomotive Co. built ten 0-6-0 switchers, Class B-29, with 19x26″ cylinders, 51″ drivers and a weight of 135,000 lbs. A total of 115 locomotives of this class were built by the American Locomotive Co. for the Lines West. In 1906, the road designed an 0-4-0, Class A-4, switcher and Juniata No. 1584, P. R. R. No. 502, 10/1906 was the first one built. These engines had 18½x24″ cylinders, 50″ drivers and weighed 116,500 lbs. and were intended for use in the congested districts.

As a result of the performance of the experimental Consolidation (H-28) type locomotive, the motive power department prepared designs for a new locomotive of this type. This design included 24x28″ cylinders, 62″ drivers and a weight of 242,000 lbs. Tractive effort was increased 8% over the H-6b class but the boiler diameter was increased from 69½ inches of the H-6 class to 76¾ inches for the new H-8 class. This larger boiler and increase in the diameter of drivers gave the new engine material advantage in the handling of trains. The design was improved to include two sub-classes, perhaps the most important feature was the substitution of 14″ piston valves on the H-8a over the 12″ on the H-8 and H-8b and the first engines of these three groups were as follows:

Juniata No. 1606, H-8, P. R. R. No. 3193, 1/1907
Juniata No. 1792, H-8a, Pa. Lines No. 9384, 11/1907
Juniata No. 1843, H-8b, P. R. R. No. 451, 3/1908

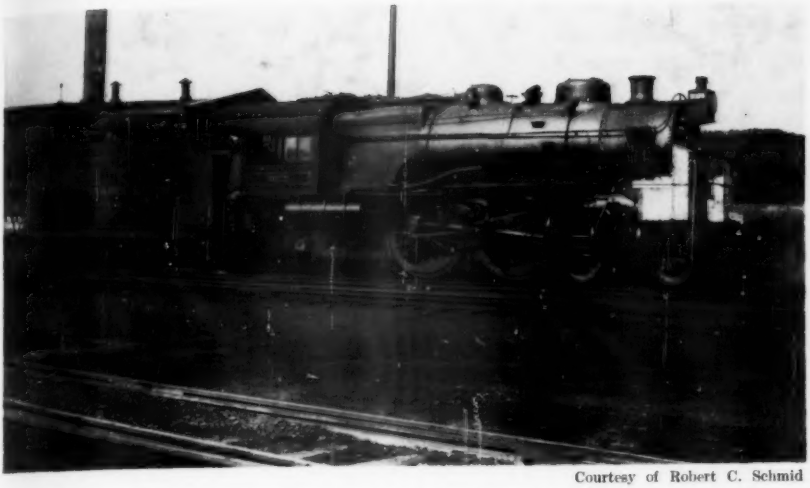
These engines, with their ample boilers, soon proved their worth in their performance. It was found that their boilers could easily supply a larger cylinder and the H-9s with a 25″ cylinder was brought out for the P. R. R. while on the Lines West, the H-10s with a 26″ cylinder was designed. The Lines West, in their H-8c design wisely allowed for the application of a stoker. The boilers were the same and these last three classes of consolidations, with their sub-classes, represented the highest development of that type of locomotive on this system.

It might be well at this point to make mention of the use of superheated steam on the "Pennsy" and how it affected the classes of locomotives already in service. Early in 1911, Pennsylvania Lines locomotive No. 7514 was sent east to Altoona and, in the Juniata Shops, a superheater of the Schmidt type was applied. The locomotive was ready for service on May 25, 1911 and was reclassified from K-2 to K-2s and was the first to receive a superheater.

Subsequent tests and service proved the value of superheated steam and a program for its application, not only to new engines but to those already built, was prepared. Whether it was the intention of the road to have a separate classification for these superheated locomotives, it is impossible to state at this late day but, the final solution resulted in the letter "s" being added to the present classification. This application resulted in some changes on the locomotives already built. The D-16b engines had their cylinders enlarged from 18½ to 20½ inches and, with their 68" drivers gave a good account of themselves in local and suburban passenger service. In the same way, the D-16d engines had their cylinders enlarged but they retained their 80" drivers. Those locomotives of the Atlantic type that were superheated retained the same size cylinders but the application resulted in some changes in classification when those locomotives were rebuilt to conform to the improved class. Locomotives of the G-4s class were given 23 inch cylinders and the improvement in this class, together with the E-3d and D-16b classes, when superheated, were most pronounced.

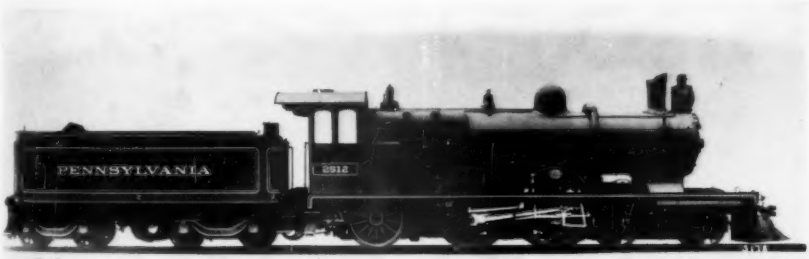
The motive power department, upon finding the boilers of the H-8 class ample to furnish steam for a 25 or 26 inch pair of cylinders, rebuilt many of this class when superheaters were applied. Generally, the H-9sa were converted from the H-8a class and the H-9sc from the H-8c class. However, on the Lines West many of the H-8c class were rebuilt to H-10s, a class used and developed by this portion of the system. Also, on the Lines West, classes E-2a, E-2b and E-2c, when superheated, were reclassified E-7s and the E-2 class became the E-7sa. Thus, armed with a P. R. R. 1920 locomotive equipment register, or one thereafter, it is sheer folly for one to assume that certain classes of locomotives in any of these registers were originally constructed to these classes and this assumption has been the means of too much mis-information having been placed in circulation by those that do not know the history of these classes or the changes made to them by the motive power department. By 1912, the program to apply superheated steam to both new locomotives and those of recent construction, was well underway.

In December of 1910, Juniata Shops under construction No. 2159, completed P. R. R. No. 5075, Class E-6, which was the forerunner of one of the most famous groups of Atlantic types in this country. She was given a boiler such as was used on the H-8 class, 22x26" cylinders, 80" drivers, weight on same was 133,300 pounds and developed a tractive effort of 27,410 lbs. After being tested at Altoona, she was sent to the Lines West and was tested against superheated and saturated Pacific type locomotives. These tests, conducted between Fort Wayne and Valparaiso, Indiana, a distance of 105 miles, in September, 1911, showed that this engine was better than the K-2 and later, it was found that this relationship existed when both engines were superheated. In the Valparaiso tests, she handled a nine car train, start to stop, at an average speed of 75.31 miles an hour; a thirteen car train under the same conditions at 66.6 miles an hour and a fifteen car train averaging 58.05 miles



Courtesy of Robert C. Schmid

P. R. R. #5075, Juniata Shops Dec. 1910, Class E-6, at Fort Wayne, Ind., while undergoing tests.

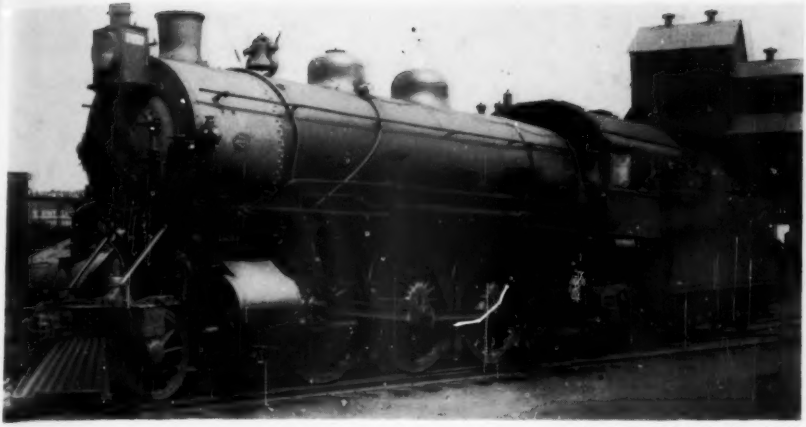


Courtesy of Pennsylvania R. R.

P. R. R. #2512. The De Glehn compound imported from France in 1904 and built that year by the Societe Alsacienne de construction Mecaniques, Belfort.

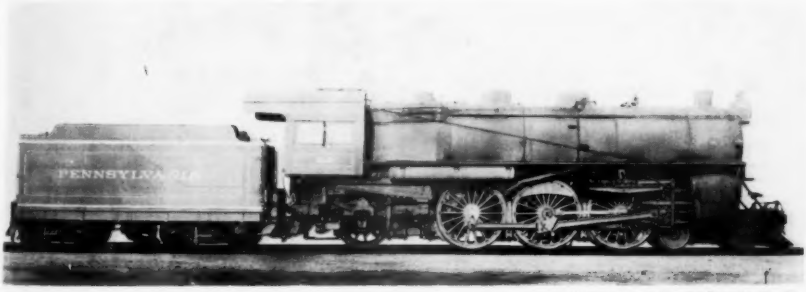
Courtesy of Pennsylvania R. R.

P. R. R. #2063. Baldwin 1902. Class F-3c.



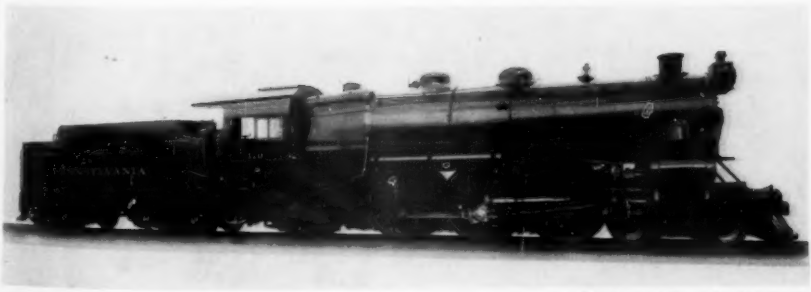
Courtesy of Robert C. Schmid

Pa. L. #7453 at Ft. Wayne, Ind. 1912. A. L. C. 1905. Class J-28.



Courtesy of Pennsylvania R. R.

P. R. R. #150. Juniata Shops Feb. 1910. Class K-2.



Courtesy of Pennsylvania R. R.

P. R. R. #170. Juniata Shops July, 1912. Class K-2sa.

an hour. This wonderful performance was partly due to a very capable fireman that was assigned this engine for these tests. With a light train of three cars, she maintained an average speed of 67.4 miles an hour from Altoona to Philadelphia, 235 miles, less three minutes for a stop at Harrisburg. From Altoona to Harrisburg she averaged 69.6 miles an hour and from Harrisburg to OB tower, Philadelphia, she averaged 68.1 miles an hour.

These tests convinced Mr. Gibbs that if the locomotive was equipped with a superheater, there would be a further improvement in performance and, he was rightly of the opinion that larger cylinders could be used. In 1912, the No. 5075 was returned to Juniata for the application of a superheater and the diameter of the cylinders increased to 23 inches. When completed, she was assigned a new number—1067. Two additional locomotives were built in May, 1912—P. R. R. No. 89, E-6s, like the No. 1067 and No. 1092, Class E-6sa, so designated because it was equipped with rotary valves and the Young-Averill valve gear, which was subsequently removed after being in service. Actual service demonstrated that these boilers were capable of furnishing steam to still larger cylinders and, in 1914, when orders were placed for the construction of eighty more of this class, these were given 23½″ cylinders and the three already built, subsequently were given the same.

These engines were designed with exceptional care. Heat treated steel was used, the pistons were hollow bored and the cross head worked in a three-bar guide, first used on the D-14a class. A screw reversing gear saved space in the cab and the front truck and leading drivers were equalized by means of a central longitudinal beam while the rear drivers and trailing truck were equalized separately on each side. This arrangement gave increased flexibility, better distribution of weight and, they rode like "Pullmans." The trailing truck casting, called the KW type, was cast in one piece and served as the rear equalizer and supported the main frames by means of sliding bearings. This subsequently became standard on this road and a modified form of it has been used on many of the others.

These locomotives were designed for the more level portions of the road and the equipment register shows the vast majority of them in the New York, Philadelphia and Washington service. Some were assigned the Philadelphia Division between Philadelphia and Harrisburg and a couple may have been assigned the Middle Division between Harrisburg and Altoona. During the years previous to World War I and during those difficult years, these E-6s engines, together with some of the E-3sd and a few of the K-2s and K-2sa classes, bore the brunt of the traffic burden on the New York Division and they did a noble job. I know that some of them, as well as some of the E-3sd engines, made two round trips daily between Philadelphia and Jersey City, a total roughly of 360 miles. There are some that feel that the "Hiawatha" Atlantics of the Milwaukee Road, with their high pressure boilers and 84″ drivers, built by ALCo. in 1935, were a superior article. Doubtless they were a faster engine than the E-6s but, on July 1, 1917, I photographed at

Torresdale, Pa., on the New York Division, the No. 1321, Class E-6s, making 55 mph with 20 loaded steel and wooden baggage cars plus a wooden rider coach and I don't believe the "Hiawatha" Atlantics, even tho' built twenty one years later could handle a train of this weight and length. Recriminations in the matter of speed are useless—I don't believe the throttles of those E-6s engines were ever pulled out to the last notch—they did not need to. For sheer doggedness in pulling, as well as speed, these big "fat-boilered" Atlantics represented the best of this type in America and, it would have been of interest to most of us if only one of the E-8s class, the super E-6s has been built. Electrification of the eastern portion of the road prevented that.

Let us return a moment to the K-2 class. I have already mentioned that one of this class was the first to have the application of the Schmidt superheater. This class was subsequently redesigned which resulted in the K-2a class and two locomotives with 72 inch drivers, Class K-2b, were built and assigned the Pittsburgh Division. There seemed to be something lacking with the K-2 locomotives. In 1913, the Lines West ordered thirty Pacific type locomotives from the Baldwin Locomotive Works, Class K-3s. These locomotives had 26x26″ cylinders, 80″ drivers, weight of locomotive 302,000 lbs. and tractive effort of 38,280 lbs. In some respects the specifications followed those of the K-1 class, designed by Mr. Gibbs, three years previous. All were superheated, all were equipped with stokers and all were used west of Pittsburgh. On January 12, 1914, the General Superintendent of Motive Power, Lines West of Pittsburgh, was authorized to create two new classes, K-5s and K-5sa. It was the intention of the Lines West to experiment with either or both of the K-2s and K-2sa classes, change the cylinders from 24 to 25 inches, together with some minor changes. This was never carried out, tho' it would have been interesting to have noted the performance but the designation of these classes must not be confused with the two locomotives of the K-5 class built in 1929. Perhaps it is fitting at this point to state that Mr. Alfred W. Gibbs, General Superintendent of Motive Power of the P. R. R. since 1903, was appointed Chief Mechanical Engineer on July 1, 1911, with offices in Philadelphia. He was succeeded by R. N. Durborrow who died in December of that year and on January 1, 1912, Mr. J. T. Wallis was appointed to that office.

In the fall of 1911, the Schenectady plant of the American Locomotive Co., completed two experimental locomotives, only one of which will be mentioned here. P. R. R. No. 3395, K-29s was completed under construction No. 50186 in December. She was the largest of this type to have been built to date and she represented the best in design of the builder and railroad. With 27x28″ cylinders, 80″ drivers, weight on same 197,800 lbs., weight of locomotive 317,000 lbs., she developed a tractive effort of 43,375 lbs. She was designed expressly for the Pittsburgh Division, Altoona to Pittsburgh and she showed that she was a vast improvement over the K-2 class. So far as I know, the locomotive never left this division and I have heard several that have spoken well of this locomotive.

Late in 1913, Mr. Wallis had designs prepared for a new Pacific type and a new freight (Mikado, 2-8-2 type) locomotive. It was his idea to have as many parts as possible interchangeable on these two classes. The boilers were exactly alike and, in order to keep it within clearances, the throat of the firebox and the lower half of the rear barrel course were flanged out of a single plate. The upper half of the rear barrel course was flanged to form the hip joints for the Belpaire firebox and this needed special dies. The machinery and running gear followed the E-6s but, the main features of the K-29s were followed and, for that reason, rather than state the new K-4s was an elongated E-6s, she actually followed the design of the K-29s but included all the features of the E-6s that could be applied. Actually, the boiler of the K-29s was larger and had more heating surface than the K-4s while the boiler of the E-6s was ⅛″ larger in diameter—if that makes any difference. On the testing plant, the K-4s was almost as efficient as the E-6s in the consumption of coal. P. R. R. No. 1737, Juniata No. 2825, completed May, 1914 was the first one delivered and, because of the need of freight engines to move the tonnage, the next K-4s as not completed until 1917. The engines of this class had 27x28″ cylinders, 80″ drivers, weight on same 201,830 lbs., weight of locomotive 308,890 lbs., and a tractive effort of 44,460 lbs. Locomotives were built as late as 1928 to these specifications, with some minor changes.

The author of this article does not share the enthusiasm for this class that many of our writers do. At this time we were approaching the limit that one back and one pair of hands could do in transferring coal from the tender to the firebox and any passenger engine with cylinders of this diameter, without a stoker, must have compensation elsewhere. Yes, it is fine to have a Pacific type with big cylinders, start a whale of a train out of the terminal but of what use is it if it has to be "flogged" over the road! In 1916 the New Haven had fifty Pacific type locomotives delivered with 26x28″ cylinders. Tests proved that with a 25x28″ cylinder, they got a sweeter running engine, used less coal and, altho' theoretically they would not start a train of as many cars they could handle their trains better. All engines were subsequently bushed down and I don't believe that there is a class of locomotives on any American railroad that accumulated the total mileage of these engines or rendered better service for their inches. Again, ALCo. No. 65000, lettered New York Central Lines No. 5000 was delivered to the Boston & Albany for experimental purposes in the spring of 1924. This locomotive with her 26x28″ cylinders, 79″ drivers was equipped with a stoker, power reverse gear and turned in a fine performance. Subsequently, the Michigan Central and "Big Four" placed orders for similar locomotives but with 25 inch cylinders. The B & A, in their order, retained the 26 inch cylinders but reduced the drivers to 75 inches. The New York Central, which had already experimented with a Pacific type rebuilt to a 4-6-4 type, was not interested. In 1926 the designs of the new Hudson type were prepared and their first locomotive was delivered in 1927.

During the U. S. R. A., the several locomotive builders and the motive power departments worked out and executed some very fine locomotive designs, designs that subsequently influenced locomotive construction after World War I. It is a debatable question whether the steam locomotive improved more during the first decade of its construction or during the decade following World War I. No matter which you feel is the more important, the other can't be neglected either. It seems to this author that during this last decade mentioned, so far as the K-4s locomotive is concerned, the road stood still. Driven under the whip of competition by a reduction in running time between New York and Chicago, after World War I, many of the K-4s locomotives were equipped with stokers, the screw reverse gear, a torment to any engineer that must start his train in a bad place, was discarded in favor of the power reverse gear and, they were modernized. As such, they turned in a better performance. Granted, the K-4s was an outstanding locomotive as designed and built in 1914, for the Pittsburgh Division for which it was intended but, by the mid-twenties, the road should have considered another type for this division or else, if they wanted a three coupled engine, used a four wheel trailing truck under the firebox. It might have been well to have considered this matter carefully before ordering the last one hundred engines from the Baldwin Works and Juniata Shops as late as 1927. If they needed them for portions of the road other than the Pittsburgh Division, I'm not so sure but that a better design could have been prepared. Two locomotives of the K-5 class were built in 1929 and 1930, one at Juniata, the other at the Baldwin Works and these were the last Pacific types built. Both had 27x28″ cylinders, 80″ drivers, wt. on same 207,600 lbs., wt. of locomotive 318,700 lbs. with a tractive effort of 54,675 lbs. P. R. R. No. 5699, built by Baldwin had poppet valves, Caprotti gear, weighed 208,370 lbs. on drivers and developed a tractive effort of 58,092 lbs.

The Mikado (2-8-2) type, Class L-1s, developed at the same time as the K-4s, turned in a fine performance and these engines were not only built at Juniata Shops but in the plants of American Locomotive Co., Baldwin and the Lima Works. The first one was P. R. R. No. 1752, Juniata No. 2816, constructed April, 1914. The next one was constructed in September of that year and Juniata built these engines, without a break, until January, 1916, to move the war tonnage. These engines had 27x30″ cylinders, 62″ drivers, wt. on same 240,200 lbs., wt. of locomotive 320,700 lbs. and developed a tractive effort of 61,470 lbs. Compared with the H-9s, these L-1s engines developed a 25% increase in tractive effort with a 30% increase in total weight. So far as it was possible, parts were interchangeable with the K-4s class and the boilers were exactly alike. The records show that one or two K-4s engines received boilers from L-1s engines after those on the K-4s engines had been damaged.

In December of 1916, P. R. R. No. 790, construction No. 3165, Class I-1s, 2-10-0 type, was completed in the Juniata Shops. This was an experimental locomotive designed for heavy service and at slower

Courtesy of American Locomotive Company

P. R. R. #3395, A. L. Co. 1911. Class K-29s.

Courtesy of Pennsylvania R. R.

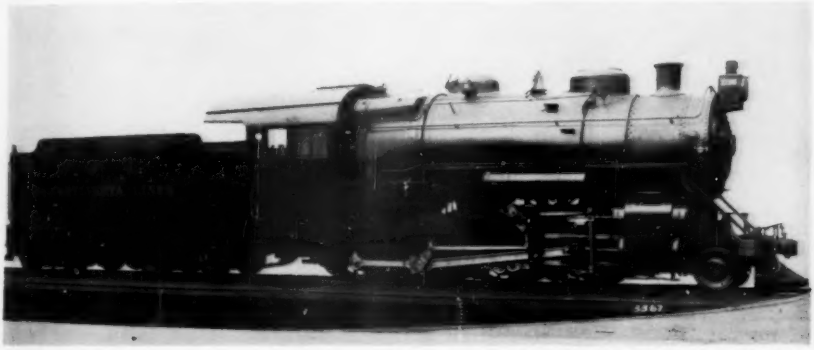
P. R. R. #1737, Juniata Shops May, 1914. Class K-4s.

Collection of R. & L. H. S.

P. R. R. #2831. Baldwin 1905. Class H-6b.

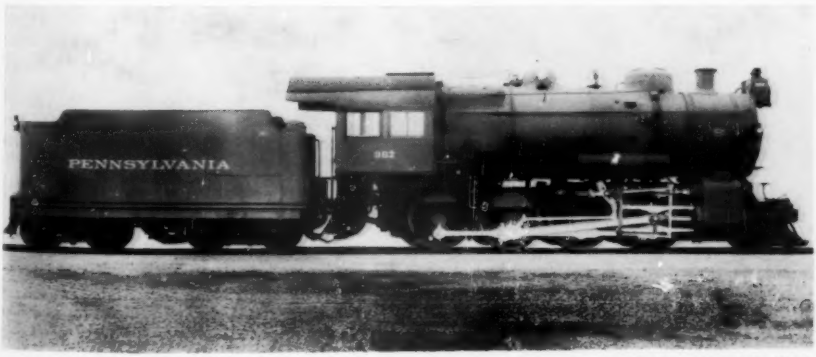
Courtesy of C. E. Fisher

P. R. R. #3199 at West Phila., 1916. Juniata Shops Jan. 1907. Class H-8s



Courtesy of Baldwin Locomotive Works

Pa. L. #7785. Baldwin 1910. Class H-8a.



Collection of R. & L. H. S.

P. R. R. #957. Juniata Shops Nov. 1908. Class H-8b.

speeds than the L-1s. Built with 30½x32″ cylinders, 62″ drivers, wt. on same 352,500 lbs., wt. of locomotive 386,100 lbs. and tractive effort of 90,000 lbs., these locomotives developed about 25% more tractive effort than the L-1s class. Designed to exert their maximum effort when cut off at about 50%, they showed on the Testing Plant that they could increase their power output 41% over the L-1s class with 12% less steam consumption. Juniata Shops commenced to build these locomotives in 1918 and they were placed in service on the Pittsburgh Division. During the years 1922-1923, the Baldwin Works completed 475 locomotives of this class. The boiler was in many respects similar to the K-4s and L-1s classes, the firebox having a combustion chamber and, these locomotives were equipped with a mechanical stoker and feedwater heater. The main and side rods were of heat treated steel as were the piston rods, crosshead pins, crank pins and driving axles. Walchaerts valve gear, controlled by a power reverse gear was used. Flanged tires were on the first and last pair of drivers, the three middle pair being blank. The cross head was a single casting of the underhung type. Each guide consisted of two forgings bolted together horizontally. Each forging was machined with two ribs which fitted into corresponding channels on the crosshead. This was an improvement of the Vogt slide first used on the D-14a locomotives in 1894. These locomotives not only gave good performance on the Pittsburgh Division but also on the level portions of the road where drag freights were handled. With a speed about equal to that of the L-1s, they could be used in fast freight service.

On the Lines West, there was designed at Fort Wayne, a Santa Fe (2-10-2) type, Class N-1s, that was used to handle the ore traffic from the lake ports. Thirty-five of these engines were built by the American Locomotive Co. and twenty-five came from the Baldwin Works. With a 30x32″ cylinder, 62″ drivers, wt. on same 351,000 lbs., wt. of engine 435,000 lbs., these engines could handle 85 loaded ore cars, rated about 7,000 tons between Ashtabula and Conway Yard. By means of lateral motion boxes on the first and fifth driving axles, blank tires on the main drivers, these engines could traverse a curve of 23 degrees. The front truck and first pair of drivers were equalized, the three intermediate drivers were equalized together and the trailing truck and rear drivers were equalized; thus the equalization was broken at two points instead of one. The boiler was of the wagon top type with the Belpaire firebox and had a maximum external diameter of 99 inches. Designed to carry 250 lb. pressure, the "pops" were set at 215. The boiler had a combustion chamber five feet long and the engine was fired by a mechanical stoker.

During the U. S. R. A., the Baldwin Works completed thirty and the American Locomotive Co., ninety-five heavy 2-10-2 type locomotives for the Lines West. Since they were of the U. S. R. A. design, they need not be discussed here. The road classified them as N-2s and, at the close of the war, when Belpaire fireboxes were substituted, these rebuilt engines were classified as N-2sa. In addition to the N-2s engines received

during the U. S. R. A., the road received a group of switching (0-6-0) locomotives which were classed as B-28s and a group of the 0-8-0 type switchers which were subsequently sold at the end of the conflict. A group of thirty-seven U. S. R. A. 2-8-2 locomotives were delivered to the Pennsylvania Lines and the Grand Rapids & Indiana. The former sold theirs to the Missouri Pacific and St. Louis-San Francisco R. Rs. while the latter wisely retained theirs and they were classed as L-2s.

At one time or another, the motive power department experimented with the Mallet articulate locomotives. In 1911, P. R. R. No. 3396, Class HH-1s (2-8-8-2 type) was delivered and placed in helper service on the Pittsburgh Division. This locomotive with (4) 27x28″ cylinders, 56″ drivers, wt. on same 437,500 lbs., wt. of engine 482,500 lbs. developed a tractive effort of 99,144 lbs. This was the other experimental locomotive built by ALCo. at the time the K-29s was built. In 1912, the Baldwin Works delivered P. R. R. No. 3397, Class CC-1s (0-8-8-0 type) with 25&39x30″ cylinders, 56″ drivers, wt. on same 386,000 lbs., with a tractive effort of 91,000 lbs. Altho' these designs were not duplicated, they influence future designs of this type. In 1919, the Baldwin Works delivered ten CC-2s (0-8-8-0 type) for heavy pushing and hump yard service on the Lines West. These locomotives had 26&40x28″ cylinders, 51″ drivers, wt. on same 458,150 lbs. and developed a tractive effort of 99,700 lbs. In June of 1919, the Juniata Shops completed under shop No. 3633, P. R. R. No. 3700, HC-1s (2-8-8-0 type) with (4) 30½x32″ cylinders, 62″ drivers, wt. on same 572,450 lbs., wt. of locomotive 603,500 lbs. developing a tractive effort of 135,000 lbs. Altho' the boiler of this "monster" was 53 feet 9½ inches in length, the large smoke box, fourteen foot firebox and combustion chamber of 11 feet 7¾ inches reduced the length of the flues to only nineteen feet. Because of the size of the combustion chamber, the throat sheet connection with the firebox was made with a fold to allow for expansion. Separate exhaust stands were provided for each pair of cylinders and four separate stacks were integrated into one casting. The locomotive was stoker fired and provided with power reversing gear. Blank tires were provided on the second and fourth pairs of the first group and second and third pairs of the last group. Altho' this locomotive gave good service on the Pittsburgh Division, it could be used only in pusher service—the draw-bar pull was too great unless all of the freight cars were equipped with the strongest M. C. B. coupler.

On February 1, 1919, Mr. Axel S. Vogt, Mechanical Engineer was retired. Shortly after his retirement, he served in an advisory capacity to the Engineering Department of the Baldwin Works until his death on November 11, 1921. On the P. R. R. he was succeeded by William F. Kiesel, Jr. On May 19, 1922 occurred the death of Alfred W. Gibbs and, in the retirement of one and the death of the other, the Motive Power Department lost two of its ablest officials. Both played an important part in the development of the steam locomotive and Mr. Gibbs was also identified with some of their earlier electric locomotives.

In June, 1923, Juniata Shops completed P. R. R. No. 987, shop No. 3769, the first G-5s class. Designed to replace the D-16sb and older engines in suburban service, these engines with their 24x28″ cylinders, 68″ drivers, wt. on same 178,000 lbs., wt. of engine 237,000 lbs. developed a tractive effort of 41,330 lbs. These engines were in fact, an E-6s locomotive with a pair of drivers substituted for the trailing wheels. They accelerated their trains rapidly and gave fine service not only on the P. R. R. but on the Long Island, some of them being built for that road.

In October of 1923, Juniata Shops completed P. R. R. No. 4700, construction No. 3819, Class M-1, 4-8-2 type developed for dual service for either fast freight or heavy passenger train service. These engines with 27x30″ cylinders, 72″ drivers, wt. on same 273,500 lbs., wt. of locomotive 383,100 lbs. had a tractive effort of 64,550 lbs. In details of construction, the I-1s design was closely followed. The boiler had a large combustion chamber and was of unusually high capacity for a passenger engine. Altho' the No. 4700 was not equipped with a stoker, provision was made for same and subsequent classes were so equipped. The engine gave good performance on the Pittsburgh Division and engines were subsequently built not only at Juniata Shops but by the Baldwin and Lima Works, with certain modifications in design.

Let us return a moment to the switching locomotives. The Class B-6 which was first brought out in 1902 was modified in 1911 with the B-6a. In January, 1916, Juniata No. 3018, P. R. R. No. 1652, Class B-6sb was delivered. With a 22x24″ cylinder, 56″ drivers, wt. on same 180,300 lbs., they developed a tractive effort of 36,140 lbs., and soon became the standard heavy switcher. In December, 1916, Juniata No. 3166, P. R. R. No. 511, Class A-5s with 20x24″ cylinders, 50″ drivers, wt. on same 131,750 lbs. and a tractive effort of 30,190 lbs. was placed in service. They were built to replace the A-4 engines in the market and warehouse sections where clearances are low and curves sharp—they were amongst the most powerful 0-4-0 switchers ever built. In May, 1925, Juniata No. 3981, P. R. R. No. 6550, Class C-1, (0-8-0 type) was the first of this type designed by the P. R. R. With 27x30″ cylinders, 56″ drivers, wt. on same 278,000 lbs., they developed a tractive effort of 76,154 lbs., and took over the switching duties performed by some of the older road locomotives and pole car and switchers as well.

In the decade that followed, the Pennsylvania R. R. expanded their electrification. As previously stated, the passenger trains between Manhattan Transfer (Newark, N. J.) to and through the new terminal in New York City, were handled by electric locomotives in 1910. The tunnels under the East River and the tracks to Sunnyside Yards in Long Island were electrified at the same time. To relieve the congestion in Broad Street Station, Philadelphia, the main line tracks to Paoli, 20 miles, were electrified for suburban passenger service in 1915 and the 12 mile branch to Chestnut Hill in 1918. Multiple unit equipment was used. During the depression years, the road wisely extended the elec-

trified portion from Manhattan Transfer to Washington, D. C., and from Philadelphia to Harrisburg, Pa. It is not the purpose of this paper to discuss the various types of locomotives, experimental or otherwise that were built but the justly famous GG-1 electric locomotives that not only reduced the running time between the termini and handled far heavier trains, produced a problem at Harrisburg. At Washington, where the trains were handed over to the connecting roads, minus some of the New York-Washington equipment, the problem was not too difficult tho' it did present itself sometimes in the northward business. But at Harrisburg, double-heading was sometimes required to handle these trains westward.

In 1938, the motive power department again experimented with articulated locomotives, first one of which was exhibited at the World's Fair in New York in 1939. A table of dimensions of these locomotives is given herewith:

S-1	(4)	22x26″	84″	281,440	608,300	67,860 lb. T. E.
Q-1	(2)	23x28″	77″	354,700	593,500	93,043
	(2)	19½x26″				
Q-2	(2)	19¾x28″	69″	393,000	619,000	115,800
	(2)	23¾x29″				
T-1	(4)	18¾x26″	80″	272,365	510,870	58,300
		All carried 300 lb. pressure				

The S-1 had the 6-4-4-6 wheel arrangement and the T-1 had the 4-4-4-4 wheel arrangement. Both were assigned to passenger service. The Q-1 had the 4-6-4-4 arrangement while the Q-2 had the 4-4-6-4 arrangement and were assigned to freight service. In 1944, P. R. R. No. 6200, S-2, 6-8-6 type, a steam turbine was delivered for experimental passenger service. These locomotives had their faults, some were retired only a few years after their construction and the advent of the diesel-electric has prevented anything further done along these lines and will doubtless shorten the service of those that remain.

In order to handle the flood of traffic resulting from World War II, the road, as an expedient, adopted a design originating with the Lima Works and the Chesapeake & Ohio Ry. In December, 1942, Juniata No. 4399, P. R. R. No. 6450, Class J-1 (2-10-4 type) was delivered. With 29x34″ cylinders, 70″ drivers, wt. on same 377,800 lbs., wt. of locomotive 572,640 lbs. these locomotives developed a tractive effort of 108,750 lbs. These engines, together with those of the J-1a class, a modification of the above, have given and are still giving very satisfactory performance.

This ends the development of the steam locomotive on the "Pennsy."

In retrospect, the following remarks may not come amiss. During the seventy odd years of the development of the steam locomotive on this system, some classes were bound to be more successful than others but, the reader must remember that those that were a success were

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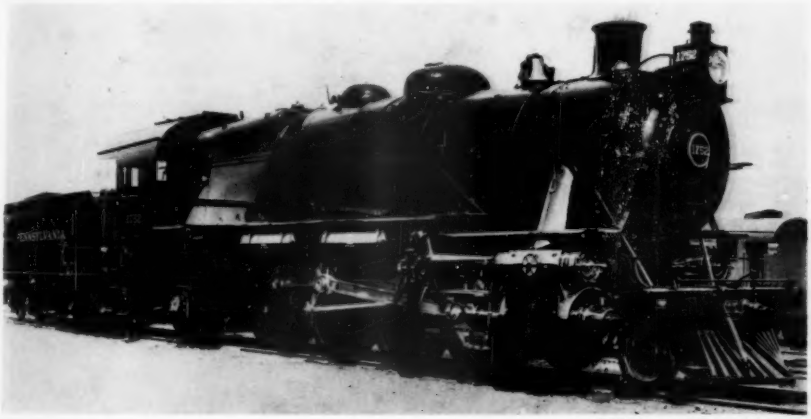
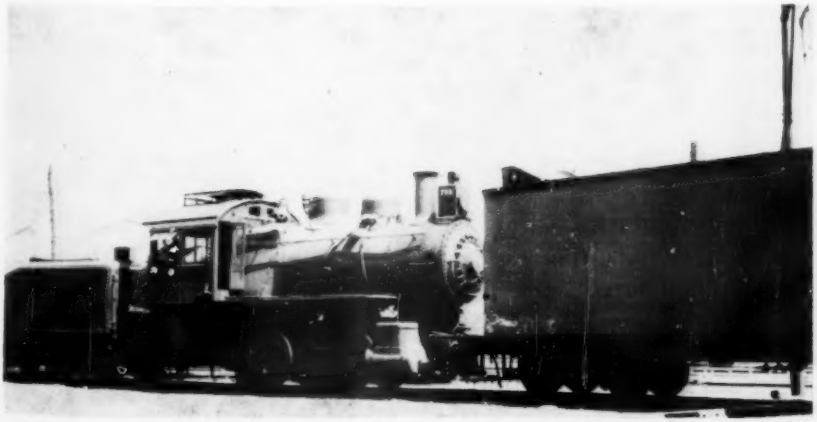
P. R. R. #3473. Juniata Shops June, 1913. Class H-9s.



Collection of R. & L. H. S.

P. R. R. #1752. Juniata Shops Apr. 1914. Class L-1s.

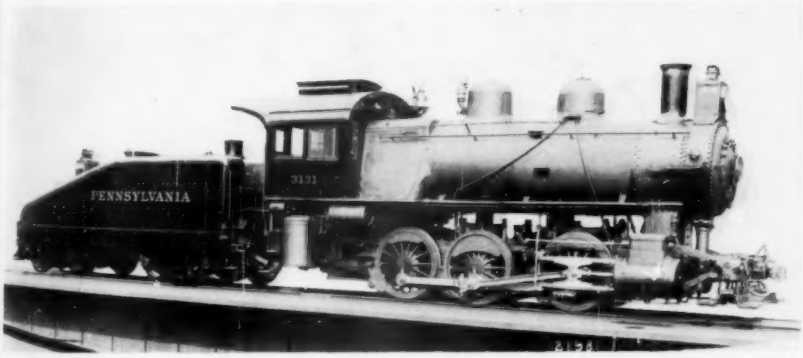


Courtesy of C. E. Fisher

P. R. R. #755 at Phila., 1915. Juniata Shops Oct. 1910. Class A-4.

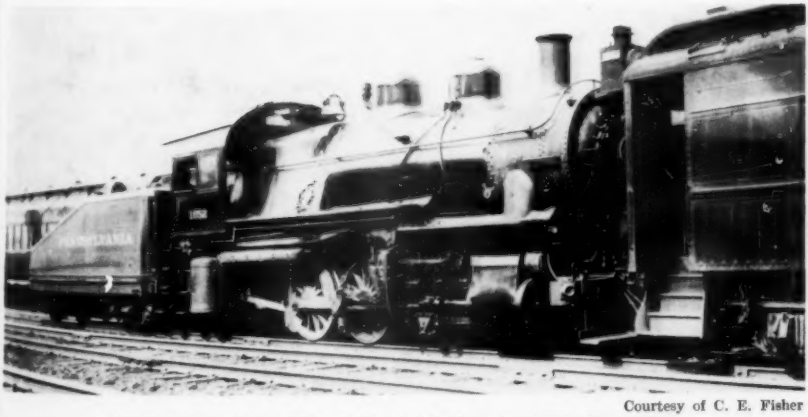
Courtesy of C. E. Fisher

P. R. R. #1289 at 52nd St., Phila., 1916. Juniata Shops Dec. 1916. Class A-5s.



Courtesy of Baldwin Locomotive Works

P. R. R. #3131. Baldwin 1906. Class B-8.



Courtesy of C. E. Fisher

P. R. R. #1652 at West Phila., 1916. Juniata Shops Jan. 1916. Class B-6sb.

built from some of the failures of others. For this reason, the management should not be criticised too severely if one or even a group of locomotives were a disappointment.

Turning back to the first specifications, it is somewhat significant that a distinction in the size of the drivers and cylinders was made in the passenger engines for service on the Pittsburgh Division and those used on other portions of the road. With the advent of the Atlantic (4-4-2) type, this was changed and all of the locomotives of this wheel arrangement had 80 inch drivers. That the majority of these classes were outstanding was due to the fine roadbed that permitted the maximum weight being carried on each axle. Furthermore, the earlier of these classes were used when trains were lighter, both in the number of cars and they were of wooden construction. Wages were lower, coal was cheaper and, altho' the majority of the westbound passenger trains out of Altoona were doubleheaded around the Horse Shoe Curve, one being dropped at Gallitzin, another engine was and could be added if needed to run through to Pittsburgh. The first Pacifics were designed with 80 inch drivers but, there is no doubt in the mind of this author that the K-2b engines, with 72 inch drivers, were designed for this very purpose. The casual dismissal that there was no noticeable difference in the performance of these two engines with the other K-2 locomotives is not born out with the wonderful performance of hundreds of other Pacific type locomotives with drivers of seventy odd inches on our American railroads. The design of the E-6s for the level portions of this road was a step in the right direction but, it seems to this author that the same could have been done for the Pittsburgh Division and that a locomotive, superior to the K-4s could have been designed, built and assigned this division. There were no through locomotive runs at the time and the train service would certainly have warranted this step. During the late 1920's, a traveler of the Mid-West, could hardly fail to note that on the Lines West, almost every train of any importance was handled by two K-4s engines. The money lost on extra crews, double spotting to take water, time lost at terminals, could well have been spent on a new design but—the road continued to build these locomotives as late as 1927. If the M-1 design of 1923 was intended to correct this, as many of us believe, then the writer withdraws his objection but, the facts remain.

Although a majority of the locomotives used on this railroad were constructed in the Altoona Machine Shops and the Juniata Shops, we must not overlook the fact that the Baldwin Works supplied a large number; that the American Locomotive Co., not only furnished nearly one thousand but many of the experimental locomotives as well and that the Lima Works furnished their quota. Thus, all played a part in shaping the development of the steam locomotive on the Pennsylvania R. R. and Pennsylvania Lines.

In closing, I want to express my appreciation for the assistance given in the preparation of these papers by my good friend, Robert

C. Schmid, a director of this Society and Chairman of our Eastern Committee of Publications. He not only took the time to check the manuscript carefully but to check the two tables that follow. Furthermore, his experience as a draftsman in the Fort Wayne Shops, was at a time when the Lines West were experimenting with their own designs. I am also indebted to Mr. H. T. Cover, Assistant Vice President and Chief of Motive Power for information relative to the newer classes of locomotives and certain facts not brought out in their records. And, to the late Alfred W. Gibbs, who helped in many ways which I appreciate more with the passing of time.

Pennsylvania Railroad

List of FIRST Engines of the Different Classes

Classification Old	New						
A	D-1	4-4-0	P. R. R.	#54	A. M. S.	# 7	9/1868
A Anth	D-7	4-4-0	P. R. R.	81	A. M. S	686	8/1882
	D-7a	4-4-0	Modification of D-7				
B	D-2	4-4-0	P. R. R.	136	A. M. S.	18	4/1869
Ba	D-2a	4-4-0	P. R. R	95	A. M. S.	539	5/1881
C	D-3	4-4-0	P. R. R.	106	A. M. S.	28	6/1869
C Anth	D-4	4-4-0	P. R. R.	912	A. M. S.	190	6/1873
Ca Anth	D-4a	4-4-0	Modification of D-4				
D	G-1	4-6-0	P. R. R.	154	Baldwin	1744	7/1868
De	G-1a	4-6-0	Modification of G-1				
E	G-2	4-6-0	P. R. R.	123	A. M. S.	22	5/1869
F	B-1	0-6-0	P. R. R.	129	A. M. S.	40	11/1869
G	D-5	4-4-0	P. R. R.	89	A. M. S.	68	11/1870
H	B-2	0-6-0	P. R. R.	781	A. M. S.	146	10/1872
I	H-1	2-8-0	P. R. R.	113	A. M. S.	271	4/1875
K	D-6	4-4-0	P. R. R.	10	A. M. S.	532	3/1881
	D-6a&6b	4-4-0	Modification of D-6				
L	None	2-4-6T	P. R. R.	4	A. M. S.	645	3/1882
L	D-16a	4-4-0	P. R. R.	88	J	346	5/1895
	D-16	4-4-0	Modification of D-16a				
M	B-3	0-6-0	P. R. R.	212	A. M. S.	705	9/1882
	B-3a	0-6-0	Modification of B-3				
M	B-4	0-6-0	P. R. R.	828	A. M. S.	1766	6/1892
M	B-4a	0-6-0	P. W. & B.	10	A. M. S.	1883	8/1893
	B-4b	0-6-0	Modification of B-4				
N	D-8	4-4-0	P. R. R.	995	A. M. S.	800	6/1883
O	D-8a	4-4-0	P. R. R.	1047	A. M. S	810	7/1883
O	D-9	4-4-0	P. Ft. W. & C.	114	A. M. S.	1430	10/1889
	D-9a	4-4-0	Modification of D-9				
O	D-10	4-4-0	N. C.	131	A. M. S.	1496	5/1890
O	D-10a	4-4-0	P. Ft. W. & C.	153	A. M. S.	1501	5/1890
P	D-11a	4-4-0	P. R. R.	1056	A. M. S.	834	8/1883
	D-11	4-4-0	Modification of D-11a				
P	D-12a	4-4-0	P. R. R.	1321	A. M. S.	1413	8/1889
	D-12	4-4-0	Modification of D-12a				
P	D-13a	4-4-0	P. W. & B.	8	A. M. S.	1754	6/1892
	D-13	4-4-0	Modification of D-13a				
P	D-13c	4-4-0	P. R. R.	1635	A. M. S.	1842	4/1893
	D-13b	4-4-0	Modification of D-13c				
P	D-14	4-4-0	P. R. R.	1658	J	249	7/1893

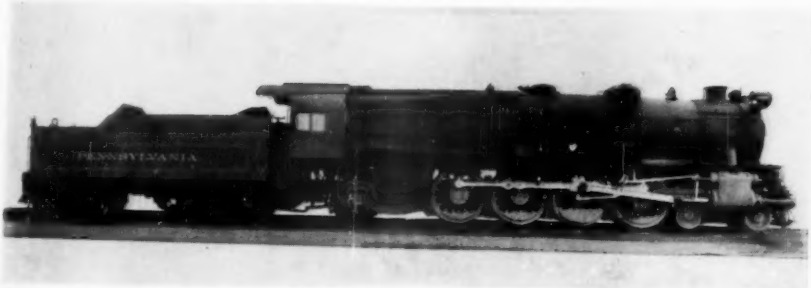
Classification							
P	D-14a	4-4-0	P. R. R.	804	J	#315	7/1894
	D-14b	4-4-0	Modification of D-14				
	D-14c	4-4-0	Modification of D-14a				
Q	A-2	0-4-0	P. R. R.	189	A. M. S.	975	6/1885
Q	A-1	0-4-0	P. R. R.	689	A. M. S.	1066	10/1886
	A-2a	0-4-0	Modification of A-2				
R	H-3	2-8-0	P. R. R.	400	A. M. S.	983	10/1885
R	H-3a	2-8-0	P. R. R.	910	A. M. S.	1466	1/1890
R	H-3b	2-8-0	P. R. R.	1623	J	198	2/1893
	H-3c	2-8-0	Modification of H-3a				
	H-3e	2-8-0	Modification of H-3				
S	H-2a	2-8-0	P. C. & St. L.	5*	A. M. S.	1117	3/1887
	H-2	2-8-0	Modification of H-2a				
T	D-15	4-4-0	P. R. R.	#1515	A.M.S.	1796	10/1892
U	A-3	0-4-0	P. W. & B.	6	J	331	1/1895
U	A-3a	0-4-0	P. R. R.	45	A. M. S.	2205	10/1901
X	G-3	4-6-0	P. Ft. W. & C.	267	Ft. W.	317	5/1892
X	G-3a	4-6-0	P. Ft. W. & C.	279	Ft. W.	330	4/1893
	A-4	0-4-0	P. R. R.	502	J	1584	10/1906
	A-5s	0-4-0	P. R. R.	511	J	3166	12/1916
	B-5	0-6-0	Formerly Class I, converted to 0-6-0				
	B-5a	0-6-0	Formerly Class H-2a, converted to 0-6-0				
	B-6	0-6-0	Pa. Lines	8026	J	942	10/1902
	B-6a	0-6-0	Wash. Term.	20	J	2284	8/1911
	B-6sb	0-6-0	P. R. R.	1652	J	3018	1/1916
	B-7	0-6-0	Formerly Class H-3, converted to 0-6-0				
	B-7a	0-6-0	Formerly Class H-3a, converted to 0-6-0				
	B-8	0-6-0	P. R. R.	44	J	1162	5/1904
	B-8a	0-6-0	Modification of B-8				
	B-29	0-6-0	Pa. Lines	7369	ALCo(S)	27880	1/1903
	C-1	0-8-0	P. R. R.	6550	J	3981	5/1925
	C-29	0-8-0	Formerly Class H-1, H-2 or H-2a, converted to 0-8-0				
	D-16b	4-4-0	P. R. R.	178	A. M. S.	2128	6/1900
	D-16c	4-4-0	P. R. R.	468	J	565	2/1899
	D-16d	4-4-0	C & P	603	J	725	10/1900
	E-1	4-4-2	P. R. R.	698	J	585	5/1899
	E-1a	4-4-2	P. R. R.	269	J	700	7/1900
	E-2	4-4-2	W. J. & S.	65	J	776	5/1901
	E-2a	4-4-2	P. Ft. W. & C.	166	J	908	6/1902
	E-2b	4-4-2	Pa. Lines	8478	ALCo(S)	26777	2/1903
	E-2c	4-4-2	Pa. Line	7376	ALCo(S)	26788	3/1903
	E-2d	4-4-2	P. R. R.	3005	J	1430	1/1906
	E-3	4-4-2	P. R. R.	621	J	833	10/1901
	E-3a	4-4-2	P. R. R.	2024	J	907	6/1902
	E-3d	4-4-2	P. R. R.	2997	J	1422	1/1906
	E-5	4-4-2	P. R. R.	1750	J	2011	3/1910
	E-6	4-4-2	P. R. R.	5075	J	2159	12/1910
	E-6s	4-4-2	P. R. R.	89	J	2426	5/1912
	E-6sa	4-4-2	P. R. R.	1092	J	2428	5/1912
	E-7s	4-4-2	Modification of E-2a, E-2b or E-2c				
	E-7sa	4-4-2	Modification of E-2				
	E-28	4-4-2	P. R. R.	2579	Baldwin	25548	4/1905
		4-4-2	Pa. Lines	7451	Baldwin	25606	5/1905
	E-29	4-4-2	P. R. R.	2760	ALCo(S)	31245	9/1905
		4-4-2	Pa. Lines	7452	ALCo(S)	37775	9/1905
	F-1	2-6-0	P. R. R.	768	J	370	12/1895

* First of this class built at Altoona. Engines of this class were built at Fort Wayne Shops in 1886.

Classification						
F-1a	2-6-0	P. R. R.	510	J	#468	2/1898
F-2	2-6-0	P. R. R.	869	J	362	10/1895
F-3	2-6-0	P. R. R.	446	Baldwin	18945	4/1901
F-3b	2-6-0	Modification of F-3				
F-3c	2-6-0	P. R. R.	35	J	853	1/1902
G-4	4-6-0	P. Ft. W. & C.	13	J	641	1/1900
G-4a	4-6-0	P. Ft. W. & C.	129	J	631	11/1899
G-4b	4-6-0	Modification of G-4a				
G-5s	4-6-0	P. R. R.	987	J	3769	6/1923
H-4	2-8-0	P. Ft. W. & C.	6	J	441	9/1897
H-5	2-8-0	P. R. R.	872	J	485	4/1898
H-6	2-8-0	P. R. R.	673	J	560	1/1899
H-6a	2-8-0	P. R. R.	1890	Baldwin	19071	5/1901
H-6b	2-8-0	P. R. R.	2811	Baldwin	26532	10/1905
H-8	2-8-0	P. R. R.	3193	J	1606	1/1907
H-8a	2-8-0	Pa. Lines	9384	J	1792	11/1907
H-8b	2-8-0	P. R. R.	451	J	1843	3/1908
H-8c	2-8-0	Pa. Lines	9900	ALCo(P)	48657	10/1910
H-9s	2-8-0	P. R. R.	3470	J	2647	6/1913
H-9sa	2-8-0	Modification of H-8a				
H-9sc	2-8-0	Modification of H-8c				
H-10s	2-8-0	Pa. Lines	7001	Baldwin	40856	11/1913
H-28	2-8-0	P. R. R.	2762	ALCo(S)	31246	9/1905
	2-8-0	Pa. Lines	7748	ALCo(S)	37777	9/1905
I-1s	2-10-0	P. R. R.	790	J	3165	12/1916
J-1	2-10-4	P. R. R.	6450	J	4399	12/1942
J-1a	2-10-4	P. R. R.	6475	J	4429	3/1943
J-28	2-6-2	P. R. R.	2761	ALCo(S)	31247	9/1905
	2-6-2	Pa. Lines	7453	ALCo(S)	37776	9/1905
K-2	4-6-2	Pa. Lines	7510	J	1983	1/1910
K-2s	4-6-2	P. R. R.	3393	J	2294	9/1911
		First superheater application to new locomotive				
K-2sa	4-6-2	P. R. R.	86	J	2349	12/1911
K-2b	4-6-2	P. R. R.	3371	J	2332	11/1911
K-3s	4-6-2	Pa. Lines	7546	Baldwin	39728	4/1913
K-4s	4-6-2	P. R. R.	1737	J	2825	5/1914
K-5	4-6-2	P. R. R.	5698	J	4205	3/1929
K-28	4-6-2	Pa. Lines	7067	ALCo(P)	41525	5/1907
K-29s	4-6-2	P. R. R.	3395	ALCo(S)	50186	12/1911
L-1s	2-8-2	P. R. R.	1752	J	2816	4/1914
L-2s	2-8-2	G. R. & I.	108	ALCo(S)	60939	3/1919
M-1	4-8-2	P. R. R.	4700	J	3819	10/1923
M-1a	4-8-2	P. R. R.	6750	J	4219	4/1930
N-1s	2-10-2	Pa. Lines	7008	ALCo(Br)	58556	12/1918
N-2s	2-10-2	Pa. Lines	7909	ALCo(Br)	60948	3/1919
N-2sa	2-10-2	Modification of N-2s				
Q-1	4-6-4-4	P. R. R.	6130	J	4383	5/1942
Q-2	4-4-6-4	P. R. R.	6131	J	4527	8/1944
S-1	6-4-4-6	P. R. R.	6100	J	4341	1/1939
S-2	6-8-6	P. R. R.	6200	B-W	70900	9/1944
T-1	4-4-4-4	P. R. R.	5500	J	4560	11/1945
CC-1s	0-8-8-0	P. R. R.	3397	Baldwin	37674	7/1912
CC-2s	0-8-8-0	Pa. Lines	7250	Baldwin	51716	4/1919
HC-1s	2-8-8-0	P. R. R.	3700	J	3633	6/1919
HH-1s	2-8-8-2	P. R. R.	3396	ALCo(S)	50187	10/1911

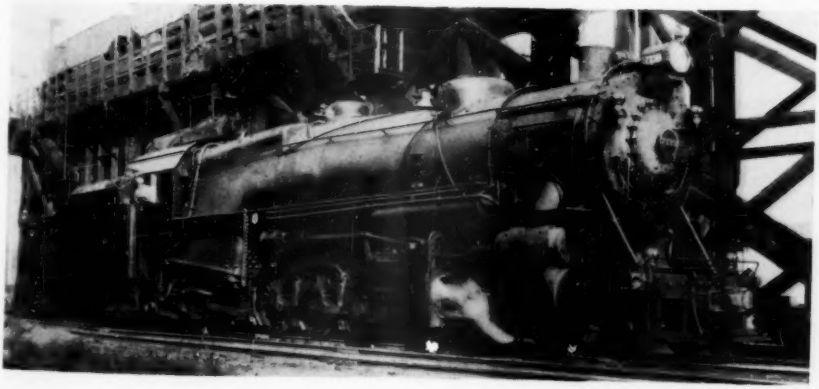
Courtesy of Pennsylvania R. R.

P. R. R. #1961. Juniata Shops Oct. 1923. Class G-5s.



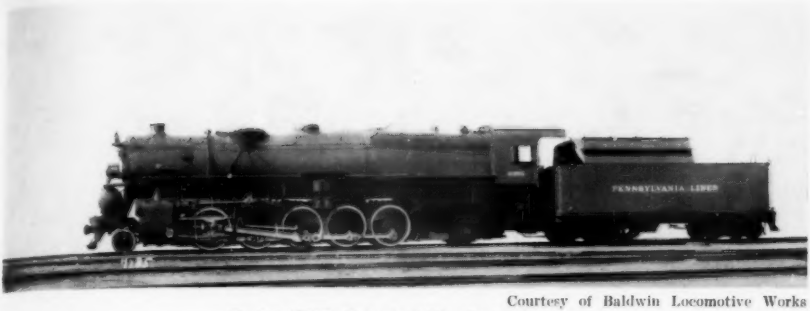
Courtesy of Pennsylvania R. R.

P. R. R. #4700. Juniata Shops Oct. 1923. Class M-1.



Courtesy of Rev. J. H. Dean

Pa. L. #7139. Baldwin July 1919. Class N-2sa. At Xenia, Ohio, Aug. 1927.

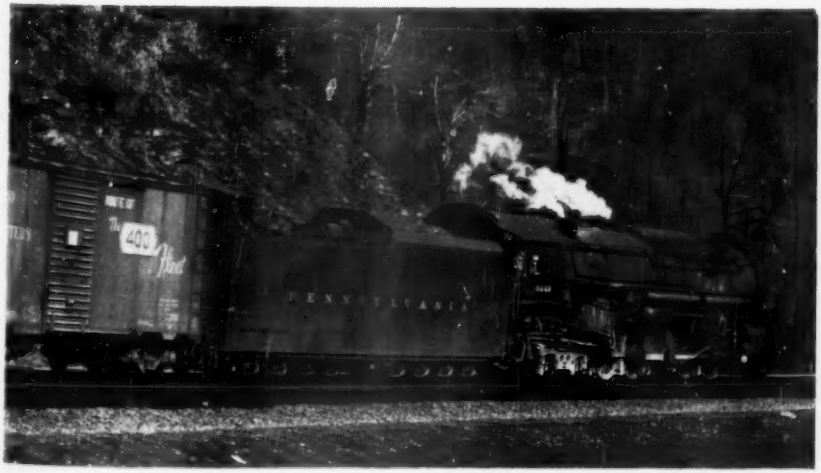


Courtesy of Baldwin Locomotive Works

Pa. L. #9353. Baldwin 1919. Class N-1s.

Collection of R. & L. H. S.

P. R. R. #4493. Baldwin 1923. Class I-1sa.



Courtesy of R. E. B. Parker

P. R. R. #6449 on Horse Shoe Curve, Nov. 1950. Juniata Shops Dec. 1943. Class J-1.

Pennsylvania Railroad

Description of Locomotive Classes

				Wt. on Drivers	Wt. of Engine	Tractive Effort	Type
A-1	15x22"	44"	125#	63500	63500	11953	0-4-0T
A-2	15x24"	50"	125#	72000	72000	11475	0-4-0
A-2a	15x24"	50"	125#	70000	70000	11475	0-4-0T
A-3	17x24"	50"	160#	82300	82300	18866	0-4-0
A-3a	17x24"	50"	160#	98000	98000	18866	0-4-0T
A-4	18½x24"	50"	185#	116500	116500	25833	0-4-0
A-5s	20x24"	50"	185#	131750	131750	30192	0-4-0
B-1	15x18"	44"	125#	71300	71300	9780	0-6-0
B-2	15x22"	44"	125#	64700	64700	11953	0-6-0
B-3	19x24"	50"	125#	91700	91700	18411	0-6-0
B-3a	19x24"	50"	125#	——	——	18411	0-6-0T
B-4	19x24"	50"	160#*	108100	108100	23566	0-6-0
B-4a	19x24"	50"	160#*	107500	107500	23566	0-6-0
B-4b	19x24"	50"	160#*	122100	122100	23566	0-6-0T
B-5	20x24"	50"	125#*	91000	91000	20400	0-6-0
B-5a	20x24"	50"	140#*	99700	99700	22848	0-6-0
B-6	22x24"	56"	205#	170000	170000	36144	0-6-0
B-6a	22x24"	56"	205#	174000	174000	36144	0-6-0
B-6s	22x24"	56"	205#	174000	174000	36144	0-6-0
B-6sa	22x24"	56"	205#	177350	177350	36144	0-6-0
B-6sb	22x24"	56"	205#	180300	180300	36144	0-6-0
B-7	20x24"	50"	140#	——	——	22848	0-6-0
B-7a	20x24"	50"	150#	122600	122600	24480	0-6-0
B-8	20x24"	56"	205#	143450	143450	29871	0-6-0
B-8a	20x24"	56"	205#	167700	167700	29871	0-6-0T
B-28s	21x28"	51"	190#	167200	167200	39102	0-6-0
B-29	19x26"	51"	180#	135000	135000	28158	0-6-0

*Some locomotives of this class carry a lower pressure than shown on this list.
B-5 and B-5a formerly H-1 and H-2a converted
B-7 and B-7a formerly H-3 and H-3a converted

C-1	27x30"	56"	250#	278000	278000	76154	0-8-0
D-1	17x24"	68"	125#	47850	77700	10837	4-4-0
D-2	18x24"	62"	125#	52500	80500	13325	4-4-0
D-2a	18x24"	68"	125#	53750	82200	12150	4-4-0
D-3	17x24"	62"	125#	50950	79100	11886	4-4-0
D-4	17x24"	62"	125#	56200	81800	11886	4-4-0
D-4a	17x24"	68"	125#	55520	82060	10837	4-4-0
D-5	15x22"	56"	125#	40700	65200	9392	4-4-0
D-6	18x24"	78"	140#	64900	96700	11863	4-4-0
D-6a	18x24"	72"	140#	64900	96700	12852	4-4-0
D-6b	18x24"	68"	140#	64900	96700	13608	4-4-0
D-7	17x24"	68"	140#	64000	93500	12138	4-4-0
D-7a	17x24"	62"	140#	65180	96330	13313	4-4-0
D-8	17x24"	62"	130#*	57700	91300	12362	4-4-0
D-8a	18x24"	62"	140#*	59000	95000	13858	4-4-0
D-9	18x24"	62"	160#	59800	96700	17057	4-4-0
D-9a	18x24"	68"	160#	66000	103000	15552	4-4-0
D-10	18x24"	62"	160#	66000	105000	17057	4-4-0
D-10a	18x24"	68"	160#	66900	103500	15552	4-4-0
D-11	18½x24"	62"	140#	74400	108700	15766	4-4-0

				Wt. on Drivers	Wt. of Engine	Tractive Effort	Type
D-11a	18½x24"	68"	140#	67800	100600	14374	4-4-0
D-12	18½x24"	62"	160#	72150	105300	18017	4-4-0
D-12a	18½x24"	68"	160#	73350	106500	16428	4-4-0
D-13	18½x24"	62"	175#	74700	109700	19707	4-4-0
D-13a	18½x24"	68"	160#	77200	112200	16428	4-4-0
D-13b	18½x24"	62"	175#	76900	112700	19707	4-4-0
D-13c	18½x24"	68"	175#	79500	114500	17968	4-4-0
D-14	18½x24"	78"	175#	82600	122600	15665	4-4-0
D-14a	19x24"	80"	175#	87300	127050	16110	4-4-0
D14b	19x24"	68"	175#	87300	127050	18952	4-4-0
D-14c	18½x24"	68"	175#	———	———	17968	4-4-0
D-15	19½&31x28"	84"	205#	95200	145500	20800	4-4-0
D-16	18½x26"	68"	185#*	93600	135300	20578	4-4-0
D-16a	18½x26"	80"	185#*	93100	134500	17491	4-4-0
D-16b	18½x26"	68"	185#*	97100	138000	20578	4-4-0
D-16sb	20½x26"	68"	175#	98500	141100	23902	4-4-0
D-16c	18½x26"	80"	185#*	94900	138700	17491	4-4-0
D-16d	18½x26"	80"	185#*	98000	138000	17491	4-4-0
D-16sd	20½x26"	80"	175#	———	———	20316	4-4-0

*Some of these classes carry a lower steam pressure

E-1	20½x26"	80"	185#	101550	173450	21447	4-4-2
E-1a	20½x26"	80"	185#	100695	169350	21447	4-4-2
E-2	20½x26"	80"	205#*	122000	185500	23799	4-4-2
E-2a	20½x26"	80"	205#*	123000	187000	23799	4-4-2
E-2b	20½x26"	80"	205#	123000	187000	23799	4-4-2
E-2c	20½x26"	80"	205#	122000	185000	23799	4-4-2
E-2d	20½x26"	80"	205#	123900	190500	23799	4-4-2
E-2sd	20½x26"	80"	205#	125800	193200	23799	4-4-2
E-3	22x26"	80"	205#*	115300	183500	27409	4-4-2
E-3a	22x26"	80"	205#*	118400	190600	27409	4-4-2
E-3sa	22x26"	80"	205#*	126100	195000	27409	4-4-2
E-3d	22x26"	80"	205#*	122900	190400	27409	4-4-2
E-3sd	22x26"	80"	205#*	127200	196600	27409	4-4-2
E-5	22x26"	80"	205#	127000	200000	27409	4-4-2
E-5s	22x26"	80"	205#	128900	208700	27409	4-4-2
E-6	22x26"	80"	205#	133300	231500	27409	4-4-2
E-6s	23½x26"	80"	205#	136000	243600	31275	4-4-2
E-6sa	22x26"	80"	205#	———	———	27409	4-4-2
E-7s	22½x26"	80"	205#	121000	191000	28670	4-4-2
E-7sa	22½x26"	80"	205#	120000	189500	28670	4-4-2
E-28	16&27x26"	80"	205#	127000	204000	23500	4-4-2
E-29	16&27x26"	80"	205#	123000	199000	23500	4-4-2

*Some of the locomotives in this class carry a lower steam pressure
E-7s formerly E-2a, E-2b or E-2c converted
E-7sa formerly E-2 converted

F-1	20x28"	62"	185#	126500	144500	28406	2-6-0
F-1a	20x28"	62"	185#*	127000	145000	28406	2-6-0
F-2	20&29x28"	62"	205#	149200	197100	35847	2-6-0
F-3	20x28"	62"	205#	142000	183000	34548	2-6-0
F-3b	20x28"	62"	205#	140300	162500	31477	2-6-0
F-3c	20x28"	62"	205#	142900	165900	31477	2-6-0
G-1	18x22"	56"	125#	58400	83500	13524	4-6-0
G-1a	18x22"	50"	125#	57710	82590	15147	4-6-0
G-2	18x22"	50"	125#	62100	84800	15147	4-6-0
G-3	19x24"	68"	180#	116000	146500	19494	4-6-0

				Wt. on Drivers	Wt. of Engine	Tractive Effort	Type
G-3a	19x24"	62"	180#	110750	136050	21381	4-6-0
G-4	22x28"*	72"	225#*	140500	184300	32798	4-6-0
G-4s	23x28"	72"	205#	149200	197100	35847	4-6-0
G-4a	20x28"	62"	225#	142000	183000	24548	4-6-0
G-4b	20x28"	62"	225#	———	———	34548	4-6-0
G-5s	24x28"	68"	205#	178000	237000	41328	4-6-0

*Originally built with 20x28" cylinders, T. E. 29750 lbs.

H-1	20x24"	50"	125#	82700	95700	20400	2-8-0
H-2	20x24"	50"	140#	100000	111000	22848	2-8-0
H-2a	20x24"	50"	140#*	95000	106000	22848	2-8-0
H-3	20x24"	50"	140#*	100590	114620	22848	2-8-0
H-3a	20x24"	50"	150#*	111500	126500	24480	2-8-0
H-3b	20x24"	50"	150#*	115000	127000	24480	2-8-0
H-3c	20x28"	50"	150#*	118000	131000	28560	2-8-0
H-3e	20x24"	50"	140#	———	———	22848	2-8-0
H-4	22x28"	56"	205#	161000	179000	42168	2-8-0
H-5	23½x28"	56"	185#	175700	196500	43421	2-8-0
H-6	22x28"	56"	205#*	166400	186500	42168	2-8-0
H-6a	22x28"	56"	205#*	175700	194500	42168	2-8-0
H-6b	22x28"	56"	205#	178700	200700	42168	2-8-0
H-6s	23x28"	56"	190#	168600	190600	42717	2-8-0
H-6sa	23x28"	56"	195#	177900	198600	43841	2-8-0
H-6sb	23x28"*	56"	205#	180900	204800	43841	2-8-0
H-8	24x28"	62"	205#	209800	242000	45327	2-8-0
H-8s	24x28"	62"	205#	217600	244800	45327	2-8-0
H-8a	24x28"	62"	205#	211000	235000	45327	2-8-0
H-8sa	24x28"	62"	205#	219500	243500	45327	2-8-0
H-8b	24x28"	62"	205#	210900	240700	45327	2-8-0
H-8sb	24x28"	62"	205#	225000	252500	45327	2-8-0
H-8c	24x28"	62"	205#	214500	239500	45327	2-8-0
H-8sc	24x28"	62"	205#	225000	249500	45327	2-8-0
H-9	25x28"	62"	205#	211000	240900	49183	2-8-0
H-9s	25x28"	62"	205#	223300	251000	49183	2-8-0
H-9sa	25x28"	62"	205#	225000	248000	49183	2-8-0
H-10s	26x28"	62"	205#	223000	247500	53197	2-8-0
H-28	23x32"	63"	200#	201500	221500	45679	2-8-0

*Some of the engines of these classes carried a lower steam pressure and some H-6sb engines had 22x28" cylinders originally and were increased to 23x28"
H-9 modification of H-8b class
H-9sa modification of H-8a class
H-9sc modification of H-8c class
H-10s modification of H-8 and H-9 classes

I-1s	30½x32"	62"	250#	341000	371000	90024	2-10-0
J-1	29x34"	70"	270#	377800	572640	108750	2-10-4
J-1a	29x34"	70"	270#	379300	574730	108750	2-10-4
J-28	21½x28"	80"	200#	161500	233500	27504	2-6-2
K-2	24x26"	80"	205#	185900	278800	32620	4-6-2
K-2s	24x26"	80"	205#	188000	283000	32620	4-6-2
K-2a	24x26"	80"	205#	178500	272000	32620	4-6-2
K-2sa	24x26"	80"	205#	191000	297000	32620	4-6-2
K-2b	24x26"	72"	205#	178500	272000	36244	4-6-2
K-2sb	24x26"	72"	205#	192500	286600	36244	4-6-2
K-3s	26x26"	80"	205#	193000	302000	38283	4-6-2
K-4s	27x28"	80"	205#	201830	308890	44460	4-6-2

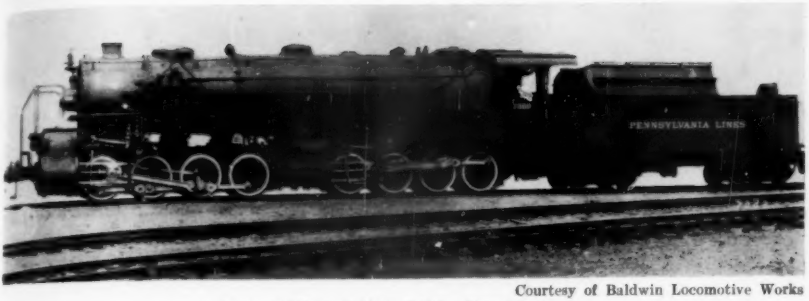
				Wt. on Drivers	Wt. of Engine	Tractive Effort	Type
K-5s*	25x26"	80"	205#	191000	297000	35394	4-6-2
K-5 #5698	27x30"	80"	250#	207600	318700	54675	4-6-2
K-28	24x26"	80"	205#	182100	273600	32620	4-6-2
K-28s	24x26"	80"	205#	182100	273600	32620	4-6-2
K-29s	27x28"	80"	200#	197800	317000	43375	4-6-2
* This class on Lines West of Pittsburgh only							
L-1s	27x30"	62"	205#	240200	320700	61465	2-8-2
M-1	27x30"	72"	250#	267000	385000	64550	4-8-2
M-1a	27x30"	72"	250#	271000	390000	64550	4-8-2
N-1s	30x32"	62"	215#	351000	435000	84890	2-10-2
N-2s	30x32"	63"	190#	293000	380000	73829	2-10-2
N-2sa	30x32"	63"	190#	297000	380700	73829	2-10-2
Q-1	(23x28"						
2 each	(19¼x26"	77"	300#	354700	593500	93043	4-6-4-4
Q-2	(19¾x28"						
2 each	(23¾x29"	69"	300#	393000	619100	115800	4-4-6-4
S-1 4 each)	22x26"	84"	300#	281440	608170	67860	6-4-4-6
T-1	18¾x26"	80"	300#	272365	510870	58300	4-4-4-4
CC-1s	25&39x30"	56"	205#	408700	408700	82716	0-8-8-0
CC-2s	26&40x28"	51"	225#	458150	458150	99792	0-8-8-0
HC-1s (4)	30½x32"	62"	205#	553000	586500	147640	2-8-8-0
HH-1s (4)	27x28"	56"	160#	437500	482500	99144	2-8-8-2

Other classes were created from locomotives from roads that came under P. R. R. control. They were not of P. R. R. design and, for that reason their dimensions are not included in the above list.

The data for the above tables was taken from P. R. R. 109-F dated June 1, 1916 and 109-H dated April 5, 1932; also from Penna. Lines register dated Aug. 1, 1918, the last engines were furnished by Mr. H. T. Cover. In the matter of the early classes, there is some variation in the weights listed in the 1884 roster but, in order to make a uniform comparison and, since the 109-F listed all classes used on the lines up to 1916, it was decided to follow the weights as furnished in that classification. The weights of the early classes are somewhat lighter than shown above but this is the reason for following the 1916 classification.

ERRATA

In Bulletin 90, the illustration of P. R. R. No. 14, erroneously titled as No. 41 opposite page 136, two of our members have called my attention to the fact that this is West Jersey No. 14 and offer substantial proof which was not shown in the original print. This causes a change in title to the effect the engine was A. M. S. No. 153, Nov. 1872, delivered as P. R. R. No. 55 and placed on the W. J. R. R. June, 1885 and numbered 14. Also, P. R. R. No. 6239, opposite page 144 should be classed D-16sb instead of D-16b. The Editor regrets these errors.

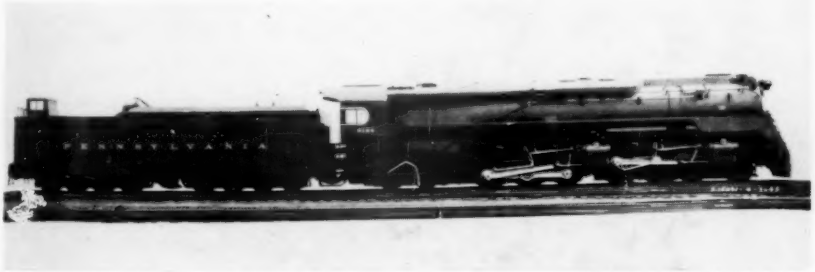


Courtesy of Baldwin Locomotive Works

Pa. L. #7250. Baldwin 1919. Class CC-2s.

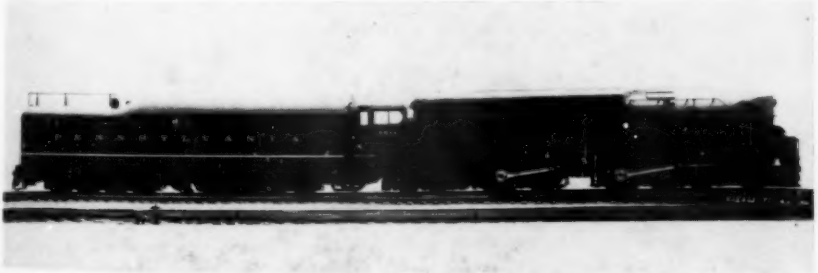
Courtesy of American Locomotive Co.

P. R. R. #3396. A. L. Co. 1911. Class HH-1s.



Courtesy of Pennsylvania R. R.

P. R. R. #6184. Juniata Shops Apr. 1945. Class Q-2.



Courtesy of Pennsylvania R. R.

P. R. R. #5511. Juniata Shops Feb. 1946. Class T-1.

John S. Powell

By Charles E. Fisher

It seems only fitting in connection with my third and last article on the steam locomotives of the Pennsylvania R. R., that some mention should be made of this gentleman, who, in the opinion of the author, was one of the outstanding train photographers of his day.

Altho' at one time a resident of the "Quaker City," I never had the pleasure of meeting him. I know that he was employed by the Baldwin Locomotive Works for a number of years, that he must have owned a 5x7 Graflex, that he knew how to use it and that he photographed the "Pennsy" trains in places that I knew so well and that he took many of these photographs during my residence in Philadelphia. A pity that we could not have met! This is the extent of my knowledge of this photographer but I will let the illustrations speak of his work.

It may not be amiss to describe briefly some of the facilities of this road in the "City of Brotherly Love" at the turn of the century. When the railroad was physically improved under the direction of President Cassatt, Philadelphia came in for its share of the reconstruction. All traffic, freight or passenger, from the west or south, destined for New York City, flowed through Philadelphia. To relieve some of this congestion, a double tracked line left the Philadelphia Division at Glen Loch, west of Philadelphia, skirted the city to the north and joined the New York Division at Morrisville—thus removing the through freights from passing through the city. Altho' many of the trains did not enter Broad Street Station, to turn these trains from one division to the other, without crossing at grade, this was accomplished by underpasses or "subways." To the novice it was somewhat complicated but, rather than leave an ugly scar on the landscape, all of these cuts and embankments were sodded which not only reduced the maintenance charges but added to the beauty. To handle the freight trains from the 52nd St. Yard (Philadelphia Division), to points south, a double track line was built clear of everything to South Philadelphia. This line stuck away up in the air and, I know of some that took advantage of it to witness the athletic contests on Franklin Field. The big, open-air roundhouse, a scourge to many of the housewives of West Philadelphia, was a source of delight to anyone interested in railroad photography. There was never any lack of locomotives but they were not always easy to photograph.

North Philadelphia was the first station stop as one came from New York. If your train was for the west and was not going into Broad Street, you crossed the Schuylkill River, passed the "Zoo" Tower, ducked into the "Pittsburgh subway," and surfacing, joined the Philadelphia Division and headed west. The "Pennsylvania Limited" always ran into Broad Street and that accounts for the observation car being directly behind the locomotive while on the New York Division. Broad Street was a stub terminal. If you were headed for the south, you

passed the "Zoo" Tower, ducked into a subway, surfaced and then submerged again for the stop at West Philadelphia. Then you continued your southward journey. For Broad Street, you followed the same pattern save that you were on the ground surface at West Philadelphia and then proceeded along the "Chinese Wall" to downtown Philadelphia —Broad Street Station. I might add that the Philadelphia Terminal Division operated all of the facilities in the immediate vicinity so that the division lines were farther out than I have represented them.

These were the interesting characteristics that a photographer of trains in Philadelphia had to know, along with a permit for that purpose. There were plenty of places to take pictures of trains, either on a curve or a straightaway. Near the "Zoo" Tower gave one a chance of taking everything that was entering or leaving and there was a curve and a signal bridge to help. Beyond North Philadelphia, near the Hale & Kilburn factory was another good spot and there were others to the north and west. John Powell knew them and used them to good advantage.

Shortly after the turn of the century, the wooden passenger equipment had been relegated to the branch lines and all passenger equipment used on the New York Division was of steel. The Pullmans were distinguished by the narrow mirrored Gothic design above the windows, making a far more handsome car from the outside than those that followed with their coach-like windows. In fact, it was difficult to tell the difference. The passenger equipment, including the Pullmans, was painted the Tuscan red and, after a good washing in the coach yards, their sides gleamed in the sunlight, especially in the late afternoon. There were the D-16 and the older "E" classes on the suburban trains, a few of the K-2 on the western and southern trains but most of the through trains were handled by the E-3 and E-6 classes. Trains were in profusion and most of them appeared with remarkable punctuality. Business was good, prices were cheap, you could still get a good dollar dinner in Kopp's cafe on South Broad Street and we had not yet become involved in European affairs. Perhaps we were living in the twilight of peace and contentment; days that certainly never will return.

We would not be human if we did not have our favorites and I'll admit that all of these E-6s engines came under this category. There was the No. 13 that headed west out of Broad Street at 4:30 P. M. or was it 4:31 P. M., there were two trains leaving at this time. There was the No. 737 usually found on the "Congressional;" the No. 435 on the "Broadway;" the No. 1067, first of the class ever built sometimes on the "Colonial" and the No. 1321 on the 3:00 P. M. for New York. Of the E-3sd engines, there was the "long-legged" No. 10, so called for her namesake of the same number, the first D-6 and Nos. 186 and 955 handled some of the best trains. Then there was No. 49, a very heavy all-express train from points on the New Haven R. R. My make-up book of trains stated the 8th car on the train was from South Norwalk, Ct., destined to Chicago or, Los Angeles when needed. This was a long car run and I often wondered when I saw the train as to the destination of that car.

The #5004, D-16a, heads out of Philadelphia with a string of wooden coaches and parlor cars for Washington.

An E-3a (#116) with an "extra" leaving Philadelphia.

An E-3sd with her train makes a pretty picture on the stone arch bridge.

An E-6s heads west over the main line in 1916.

P. R. R. #2761, J-28 with the "Manhattan Ltd." near "Zoo" Tower, Philadelphia.

A K-2 in the Philadelphia district.

North Philadelphia Station was an ideal spot to visit to watch the trains. The raised platform brought you within speaking distance of the engineer and few there were in those days that were not willing to discuss in the time allowed the merits of that particular engine. You could easily look into the cab with the shining gauges and levers, fire-door on the latch and "pops" about ready to blow. I recall one night that a "kindred soul" and myself made our way to this point to witness No. 37, the "Iron City Express," the only train then that did not stop in Philadelphia, pass through the station. Promptly at 1.20 A. M., behind an E-6s came a dimly lighted coach, a club car with the shades drawn and five sleepers followed. The train drifted through slowly but, it took us some time to make our way home to West Philadelphia at that hour.

Right after supper, on a summer evening, one could board a train and arrive in time to witness the several trains, led by the "St. Louisan" that left New York at 6:00 P. M. No matter how long you remained, there was always another one due, from some place, according to your Employes' Timetable. The thing that always impressed me was the seeming ease and punctuality with which these E-6 engines handled their trains, whether of five, seven, ten or twelve cars—they had that "extra" to do it. Walking from one end to the other of those long station platforms was a good way to settle one's dinner and, sometimes there was a gentleman, little above the average height, well groomed, one that did not hesitate to address the engine crews and they in turn always answered him respectfully. Yes, "A. W. G." liked to visit North Philadelphia and witness the performance of *his* engines and you could not help but admire him for doing it.

Recollections of the P. R. R. Station at Lima, Ohio

By Dwight F. Fullerton

The station as you see it today was built in 1887. It was successor to a long, low wooden building, whose west end was just about even with the east end of the new one. It crowded pretty close to the C. H. & D., and had a common wooden platform with that road, an ell south of the P. R. R., and west of the C. H. & D.—L. E. & W. joint station, or rather west of the joint right-of-way of these two roads. I have a large photograph of the new P. R. R. station when it was nearly new, the photographer having stood on a flat car full of new stone for the C. H. & D. station, which was built about 1892.

There have never been any basic additions to the P. R. R. Station since it was built. The place where you talked to the ticket-seller was the wall between the large, or main, waiting room and the old baggage room, which has been raised a little to make the ticket office even with the waiting room. When the present ticket office was the baggage room, there were no means of communication between it and the main waiting room, except by going outside and entering the waiting room by the north door. I will not try to estimate the measurements of the waiting room. At first, there were large, brick fireplaces in the east waiting room, and a smaller one in the west room. The west room was long north and south, about 25 feet wide, and was the Ladies' Waiting room. The fireplaces were of very fine "inside" pressed brick and were vaulted, or built to a point overhead, somewhat like those in the old Polk Street station in Chicago, but not so large. They were very fine jobs of bricklaying, and over the one in the large waiting room, in the middle of the east wall, was a painting of the Great Seal of the State of Ohio. I do not know who did this painting, but it was retouched from time to time by the "Michael Angelo" of the P. Ft. W. & C. Ry. Co. painters, one Charles J. Turney, of Upper Sandusky, Ohio.

My father was a very quiet man—more like a minister than a baggage agent, and he had many friends in town on the "pike." Charley and Dad were quite friendly—railroading was the last thing they talked about.

On the track side of the baggage room was a large, heavy, sliding door to allow trucks of mail and express to be run into the room, and another door at the opposite side leading to the driveway. They were the only doors to the baggage room. My Dad's desk was over in the northeast corner, enclosed by a wooden grill-work and a desk-high wall with a what-not cupboard, and the bagge room telephone *on* the *wall*. There were two fire-buckets on the west wall marked "For Fire Only" and a stretcher permanently anchored to the same wall. As far back as I can remember, the baggage room was heated by a big depot stove and, if there was any connection to the hot air ducts of the

Courtesy of Dr. E. B. Pedlow and John H. Keller

The Pennsylvania Depot at Lima, Ohio.

main depot, they were of little use, being so far from the furnace in the basement. The room was lighted in the daytime by two 3-foot square windows high in the east wall, with iron grills over them.

Between the main and the "Ladies" waiting room there was a 12-foot passage or breezeway, and what was left of the width of the building was taken up by the toilet facilities for both men and women, and by the ticket office, which was small, on the track or north side. The ticket office had a slight bay of about four feet trackwards, and in this offset, facing east, was the door to the telegraph office stairs, which, by reason of lack of room, were steep and treacherous, although there was a wooden rail along side of them. The west offset of the ticket office was longer than the east one, which cut a little into the length of the ladies waiting room. The shelters which flanked all of this are now just as they were when built, although they have been extended west about 150 feet. The large water tub, built on a wooden shoring, right up against the building, outside of the west windows of the ladies waiting room, was dismantled about 1896. The station grounds used to be beautiful, the circles within the drives were lawns, with immense canna beds in their centers, and were taken care of mostly by none other than John Fullerton. The horticulture was under the supervision of the head gardener, whose headquarters and greenhouses were at Sewickly, Pa.

At the present time, the old baggage room is the ticket office, the old ladies' waiting room is the baggage room, and the office of the baggage room is in the old ticket office. This arrangement makes it unnecessary to move material to and from trains between the ticket office, or old ticket office bay, and the eastward track, where we always had trouble, because it was so narrow. There were three plank crossings, one at the east end of the brick, one just opposite the present baggage room, and one at the west end of the brick, or at Union Street tunnel. In the early days there was a planking between the mains, about ten feet wide, so that all trains worked from the south side. The P. Ft. W. & C. was not strictly a two-track line at first, or for many years after for that matter. Bucyrus to Lafayette was single track until about 1894 or 1895. For many years there was a row of saloons and bawdy houses on the property opposite the station, to the north. The P. R. R. owned a strip for the C. H. & D. interchange, but they afterwards bought this piece and the houses were torn down, the tracks straightened, and platform laid on the north side.

For years, the C. H. & D. controlled the crossing, and its gateman operated a two-track gate, which swung around by hand. It was a full stop for the P. Ft. W. & C. In the eighth grade at school, we had one hour per week of German language. I liked Miss Nettie Shook, who taught this class, and she marveled at my learning so quickly what little I did learn. Finally I told her my secret, old Peter Badertscher, who watched the crossing, was also tutoring me and doing a swell job of it, too.

The old station has needed a lot done to it for the last ten years or more. For a long time, the two agents—passenger and freight—handled these accounts separately. "Mr. Smith" was the P. R. R. ticket agent, and "Mr. Brown" was P. R. R. freight agent. For the last twenty years, one man has simply been the "Pennsylvania Agent at Lima, Ohio."

It may be that my recollections have warped with time, but, during the years I lived in Lima as a "sprout," and up to the time I left there, about 1907, that passenger station was a busy place. You had to be a good strategist, when trains would double up on you, to be able to get over to the westward side and not get cut off. The long trains have played havoc with all the arrangements at Lima. The station should be a lot further west and handy to Main Street. Most of the long trains, if they can nose up on Main Street westward, foul the B. & O. There is no place to do "housework" except right up into the passenger platform. Both ends are simply plugged up.

The south property line at the P. R. R. station is about 110 feet south of the eastward main track and, to the left, meets a property line of the C. H. & D., which I think is about the same width; then this 100 or 110 feet continues westward to about Elizabeth Street (the first street west of Main), and then narrows down somewhat. In order to get rid of the undesirable shacks north of the main tracks, as stated above, I think the P. R. R. bought all of the land contained in the triangle formed by the B. & O. interchange, and that it is still vacant, as it has been for years. This triangle is reached by driving under the mains via the Union Street tunnel, or around Main into Pearl Street, and turning in there over the interchange. It is open, to all intents and purposes, to the public in order to meet westward trains. Until this change was made, all business was done on the depot side.

For many years the P. R. R. station was the best in Lima and still is architecturally. The C. H. & D. station was a good station, but plain and had no zip, as you might call it. The Erie got along with the old wooden one built in 1881, until it burned down about 1941. Then they built one of these "synthetic" or modernistic, stations, which has no heavy work on it. The best depot built in Lima, in my memory, was the little station on the Detroit & Lima Northern, built about 1899, at the southwest corner of Wayne Street and the B. & O. right-of-way. (Wayne is the street just south of and abutting the C. H. & D. depot property). That was a stone station, small, but very artistic. When the Ohio Southern and the D. & L. M. were merged (and somewhat later became the D. T. & I.), this little station was torn down, and access to it, as well as to what industries the two little roads tapped on the way into it, was done away with, and the wooden trestle over "Hog Creek," that led the trains into town from the wye, was taken down.

The curve to the west of the station (at about McDonel Street) is the beginning of the tangent maintained all of the way to Chicago. The old Haller property, which it misses by making this slew to the

northwest, is the highest point in Allen County. The furthest visible point eastward is "Tony's Nose" Cemetery, four miles east of Lima, where the tangent is taken up eastward, almost without a break, to Crestline. Lima is on the short, flat tangent connecting the "Tony's Nose" stretch with the Chicago angle. The pike straightens out at Delphos and Van Wert to go through these towns, and there is a deviation at Ft. Wayne, also. This simplified land titles somewhat.

Writing about these things brings back a tornado of old memories and tempts me to go on and on, but these things would be mostly personal and would not differ materially from the experiences of thousands of other "fans;" so, having written all I know about the station and its surroundings, it is fitting that I close this piece.

Worth Reading

Compiled by ELIZABETH O. CULLEN, *Librarian, Bureau of Railway Economics, Association of American Railroads,* Washington 6, D. C.

Books and Pamphlets

ABC's of Air Brakes—with Air Brake Dictionary, Vol. 1, by Carl M. Drennan. viii, 243 p. diagrs. New York 7, N. Y., Simmons-Boardman Publishing Corporation. $4.75.

The Bessemer Story. 18 p. illus. map. Pittsburgh 30, Pa., Bessemer & Lake Erie Railroad Co. Free on request. " . . . a story which includes same interesting chapters in railroad history, going back for more than three-quarters of a century."

Bibliography of Railroad Literature—5th Edition, June 1954, by Association of American Railroads, Washington 6, D. C. 56 pp. Free on request. Classified by "Juvenile Books;" "General Literature;" "Model Railroading;" "Railroad Statistics;" "Railroad and Travel Periodicals;" "Company Periodicals;" "Publishers' Addresses."

A Brief Sketch of Japanese National Railways (Equipment and Facilities)—1953. 240 proc. p. Folded map, illus., diagrams, organization chart. Tokyo, Japan, The Japanese National Railways.

Buffalo, Brantford & Goderich Railway, 1854 Centenary—1954. by Dr. Frank Walker. 6 p., incl. illus., map and Locomotive Roster as of 1858. Upper Canada Railway Society Bulletin No. 39, Jan., 1954. Society's address: Box 122, Terminal "A," Toronto, Canada.

Business Opportunities in Atomic Energy—Proceedings of a Meeting for Members and Guests, March 15-16, 1954. [198] p. illus., diagrs. New York 16, New York, Atomic Energy Forum. $6.00.

Chemins de Fer, by Georges Bohl. "A l'usage des agents du matériel et de la traction, des constructeurs de locomotives, et de tous les amis des chemins de fer." 62nd ed., 1954. 2 vols.: I. Traction; II. Matériel, Voie, Exploitation. Paris, VI France, Dunod. On covers: "Aide-Memoire Dunod."

Choice Industrial Sites in America's Great Southeast and Southwest [56] p., illus., maps. St. Louis 1, Mo., Development Department, St. Louis-San Francisco Railway. Free on request.

Collective Bargaining in the Railroad Industry, by Jacob J. Kaufman. xi, 235 p. New York, King's Crown Press, Columbia University. $3.75.

Colorful California Names—Their History and Meaning, compiled by Thomas P. Brown, with a Foreword by Nancy Newhall. 43 p. San Francisco, Calif., American Trust Co. Free on request. " . . . The Pageant of History in Northern California—reproduced from an original painting commemorating the 100th Anniversary of American Trust Company, San Francisco, by the distinguished California artist, Millard Sheets." pp. 22-23.

Costa Rican Railway Company Ltd. and Northern Railway Company, compiled and edited by the Administrative Staff of the Northern Railway Company, San José, Costa Rica. 200 p. incl. illustrations. Map in color. Text in Spanish and in English.

Die Deutsche Bundesbahn. Verbesset ihre Listungen—sie MODERNISIERT—sie RATIONALSIERT—sie BAUT AUF. 32 p. illus., map. Frankfurt (Main), Germany, Hauptverwaltung der Deutsche Bundesbahn, Pressedient. Free on request.

Directory of Railway Officials & Year Book 1954-1955—(Sixtieth Year of Publication), compiled from Official Sources under the direction of The Editor of *The Railway Gazette*. ii. 530 p., 221 adv. p. London, England, Tothill Press Limited. 40 shillings. " . . . as we have received more replies to our enquiries this time the revision of individual entries has been correspondingly more extensive. The principal change is the disappearance of the entry relating to the Railway Executive in view of the absorption of the Executive by the British Transport Commission on October 1 last, and the officers of the Executive appear with their new designations in the Commission or the regions. . . .

"Although we have still been unable to obtain reliable information on the railways of China, Russia, and most of the countries of Eastern Europe, we have received and included particulars of those of the Republic of Korea, the first information to reach us from Korea since 1937. . . . "

Economics of Transportation—Fourth Edition 1954, by D. Philip Locklin. xiv, 916 p. maps. Homewood, Illinois, Richard D. Irwin, Inc. $8.65. " . . . The course of events in this dynamic and ever-changing segment of the economy makes another revision of the book necessary if it is to serve its greatest usefulness." (p. ix).

Electric Trains and Locomotives, by B. K. Cooper. xvii, 111 p., illus. London, England, Leonard Hill Ltd. $2.25.

Elements of Railway Signaling—50th Year 1904-1954. 1219 p., illus., diagrs. Rochester 2, N. Y., General Railway Signal Company. $3.50. Its Handbook No. 50, June 1954.

Fair Rewards and Just Compensation, Common Carrier Service—Standards under the Interstate Commerce Act, by Clyde B. Aitchison. vii, 128 p. Washington, D. C., The Association of Interstate Commerce Commission Practitioners. $3.50.

Federal Aids to Domestic Transportation—Statement of the Association of American Railroads Submitted to The Commission on Intergovernmental Relations, Washington, D. C., 1954. Washington 6, D. C., Association of American Railroads. Free on request. Cover-title, 23 p.

"Freight Tariffs," by Charles S. Baxter, 8 proc. 1. Washington 6, D. C., Railroads' Tariff Research Group. Free on request. Address by Chairman of Group before Mountain-Pacific States Conference of Public Service Commissions, Sun Valley, Idaho, June 22, 1954.

From Mine to Market—The History of Coal Transportation on the Norfolk and Western Railway, by Joseph T. Lambie. xviii, 380 p. illus., graphs, maps. New York, N. Y., New York University Press.

Fruit Guide [for western states], prepared and edited by Joe W. Jarvis. 64 p., illus. Omaha 2, Nebraska, Union Pacific Railroad Agricultural Development Department. Free on request.

Great Britain. Railway Reorganization Scheme. Section I—Explanatory Statement. Section II—The British Transport Commission (Organization) Scheme, 1954. 21 p. London, England, Her Majesty's Stationery Office. 9 pence. May be purchased from British Information Sales Office, 30 Rockefeller Plaza, New York 20, N. Y. for 25 cents. "Press reactions to the White Paper" in Railway Gazette, July 23, 1954, p. 88.

History and Development of Railway Signaling, by Association of American Railroads. Signal Section. Chapter I of its American Railway Signaling Principles and Practices. 167 p. illus. Chicago 5, Ill., A.A.R. Signal Section. $1.25. For the "firsts" see especially *Section 18. Chronogical* [1832-1953], pp. 102-167. *The Origin and History of the Signal Section,* Section 13, pp. 84-92.

A History of the Kansas Central Railway, 1871-1935, by Harold Crimins. 34 p., illus. Emporia, Kansas, Kansas State Teachers College. The Emporia State Research Studies Vol. 2, No. 4, June 1954.

The History of Transportation in Wayne County, Indiana. Part I-V, by Luther M. Feeger, associate editor, The Palladium-Item, Richmond, Indiana. Reprinted from Palladium-Item, in which they appeared originally at time of centennial of first locomotive to arrive in Richmond, March 19, 1863.

How To Travel By Train—A Basic Information Guide for the Railroad Traveler. New York 8, N. Y., American Car and Foundry Company. Free on request. Reprinted from May-June, 1954 issue of ACF's *Wheels.*

Index to Operating Expenses. "An alphabetic arrangement of items includible in the primary accounts in operating expenses in the Interstate Commerce Commission Uniform System of Accounts for railroad companies including cross-references to interpretations issued in Accounting Bulletin No. 15 and "A" cases related to operating expenses." January 1, 1954. 232 p. Washington 6, D. C., Association of American Railroads. Finance, Accounting, Taxation and Valuation Department. $1.25.

Indian Railways 1952-53, by General Manager of India Railways. iii, li, 116 p. graphs, tables. New Delhi, India, Ministry of Railways.

"Jay Gould," by Julius Grodinsky. 7, 4 proc. p. A paper presented at the 12th annual meeting of The Lexington Group, Madison, Wisconsin, April 21, 1954. Accompanies the Lexington Group letter dated June 28, 1954. "Reproduced and distributed by The Lexington Group with the express permission of the author. No portion of this paper may be used or reproduced without the author's express permission." (p. 7)

A Look Beyond The Station . . . What's Happening with the Railroads? 36 p., illus. New York 17, N. Y., Committee of Railroad Suppliers. Free on request. " . . . Probably no other industry has made

so many fundamental advances, nor developed and used so many technological improvements . . . ''

The Midland Railway, by Hamilton Ellis. viii, 192 p., illus., fold. map. London, England, Ian Allen, Ltd. $3.75. '' . . . a short general survey of the Midland Railway, and of the trains which worked it, in days to which we cannot return.''

The Midland Story. [44] p. illus. Springfield, Illinois, Chicago & Illinois Railway Company. Public Relations Department. Free on request.

Monorail Systems for Mass Rapid Transit, by Edward H. Anson, senior vice president—Gibbs & Hill, Inc., consulting engineers, New York-Los Angeles. 16 p., illus., diagrs. Presented in Detroit, Mich., April 27, 1954. Sponsored by The Transportation Institute of The University of Michigan and The Engineering Society of Detroit.

More About R D C. [24] p. illus. Philadelphia 32, Penna., The Budd Company. Free on request.

Norwegian State Railways centennial publications: *Vart Yrke, 1954, No. 2.* [NSB centennial celebration issue. Illus.] Oslo, Norway, Norges Statsbaner; *Morganbladet, Oslo, June 5, 1954*—Special NSB Centennial Number; *Norwegian American Commerce, June 1954,* containing Editorial ''Centennial of Railroading,'' p. 3 and ''Railroading in Norway,'' by H. Clayhills, pp. 4-6; *HVA er Jernbanen? Utgitt Til Norges Statsmaners 100 Ars Jubileum 1954; Norges Statebaner. First Day Cover. N S B 100 AR 1854-1954,* with special centennial postage stamps.

Notes on Railroad Location and Construction Procedures from The School of Experience, by A. Given, retired location engineer, Pacific System, Southern Pacific Company. vii, 43 p. Chicago 5, Ill., American Railway Engineering Association. 50 cents. Copies sent to heads of engineering departments of accredited colleges and universities in the U.S.A., and Canada, on recommendation of A.R.E.A. Comm. 24—Co-operative Relations with Universities. Readers may like to have a copy handy when reading the articles on reconnaissance, and location and construction of Quebec, North Shore and Labrador, listed in ''Articles in Periodicals.''

A Plan for Prompt Rehabilitation of the L. I. R. R.—A Report to Governor Dewey, by Long Island Transit Authority, 270 Broadway, New York City. 23 p.

Prize Bridges Through the Years 1928-1952. 172 p., illus. New York, American Institute of Steel Construction, Inc. Includes several railroad bridges.

Railroad Improvement in the South, by The Sasi Committee on Railway Transportation, May 23, 1954. A Special Report. 4,3 proc. 1. tables. Atlanta, Ga., The Southern Association of Science and Industry, Inc.

The Railroads in 1953—A Financial Report on the Industry. 8 p. Washington 5, D. C., Federation for Railway Progress, June 1954.

Survey of Railway Car Repair Shops. 27 p. New York 7, N. Y., Simmons-Boardman Publishing Corporation. Research Department. $2.00. " . . . It covers 121 railroads in the United States, Canada and Central America."

Technical Analysis of Plan for the Prompt Rehabilitation of the Long Island Rail Road, by Colonel S. H. Bingham. 24 p., illus., diagrs. New York 7, N. Y., Long Island Transit Authority.

Through All Europe By Train. Time-Table in force from May 23rd 1954. 60 p. Edited and distributed by Centre d'Informations des Chemins de Fer Européens (C.I.C.E.) through Conference of European Railroad Representatives, New York City, listed on inside back cover.

Trailers-on-Flat-Cars — "Piggybacks" — Memorandum, July 19, 1954, Listing Material Published from February to July 15, 1954. 26 proc. 1. Washington 6, D. C. Association of American Railroads. Bureau of Railway Economics Library. Free on request. The Interstate Commerce Commission's decision in Docket No. 31375—Movement of Highway Trailers by Rail was decided on July 30, 1954. Hearings in its I. & S. Docket No. 6214 were held July 27-30, then recessed to October 12.

TRAINS, by Robert Selph Henry. 20th Anniversary Edition. 136 p. illus., end-paper maps: "A Century of Railroads in America." Indianapolis, Indiana, The Bobbs-Merrill Company, Inc. $3.00. " . . . In the four years since *Trains* was last revised, new developments in railroading have been almost revolutionary. Push-button yards are past the experimental stage. Diesels have increased from one-fifth to four-fifths of all the locomotives. . . . The latest track, operational equipment, engine design and new types of locomotives, trains of cars, servicing developments have been added to this edition. . . . "

Transport Regulation in Peace and War, by Julius H. Parmelee, consulting economist, Association of American Railroads. Cover-title, 29 proc. 1. Address at Transportation School, Fort Eustis, Virginia, March 26, 1954. Free on request to Mr. Parmelee, Room 1028 Transportation Building, Washington 6, D. C.

Transportation and the Growth of Cities, by Harlan W. Gilmore. vi, 170 p. Glencoe, Illinois, The Free Press. $3.00.

Verkehrliche und Wirtschaftliche Auswirkung der Elektrifizierung der Eisenbahnen in Schweden, by Arne Bjorberg. 9 p. Sonderdruck aud dem Jahrbuch "Science und Strasse 1954."

Die wichtigsten Grundfragen der Eisenbahnwarbung, by Dr. Hans Suss. Vol. 42 of the Swiss Contribution to Transport Science. 133 p. Bern, Switzerland, Sta,pfli & Cie. 8.65 Swiss francs.

Articles in Periodicals

Alabama's Political Revolution of 1904, by James F. Doster. The Alabama Review, University of Alabama, April 1954, pp. 85-98. " . . . The election was not of a governor or of a legislature but of a railroad commissioner. A new leader, Braxton Bragg Comer, had found an

issue, and he had stormed the citadels of conservatism. The issue was freight-rate reform. . . . " (p. 87)

Anyone For Monorail? Fortune, July 1954, pp. 106-109, 128, 133. Illus. " . . . Can major U. S. cities afford new rapid-transit facilities—or afford to do without them? Los Angeles, facing this urgent question, is being urged to buy a forty-five-mile monorail line for $165 million."

The Atomic Locomotive, by Lyle B. Borst and K. W. Petty, University of Utah Physics Department. Railway Progress, July 1954, pp. 4-9. Illus. and graphs. " . . . Since the completion of the [feasibility] study, the University of Utah has negotiated patent arrangements with Babcock and Wilcox, covering unique features of the reactor design. At the present time, Babcock and Wilcox Co. are undertaking engineering design studies and making laboratory tests looking toward a complete design and eventual construction of an A-locomotive." (p. 9).

Belgian Electric Rolling Stock, by F. Baeynes, chief engineer, Belgian National Railways. Railway Gazette, London, England. August 6, 1954, pp. 155-158. Illus. " . . . Stages in 20 years development of multiple-unit trains and heavy locomotives on the Belgian National Railways."

Canada's First Subway—Three papers describing *Job Control*, by W. H. Paterson . . . ; Electrical Equipment, by J. Y. Doran; *Cars, Shops and Mechanical Equipment*, by J. G. Inglis. The Engineering Journal, The Engineering Institute of Canada, April 1954, pp. 379-398. Map, Illus.

Centenaire de la "Ligne des Souverains"—Batigolles-Auteuil, by Roger Commauly. La Vie du Rail-Notre Métier, nos. 454, pp. 3-6; July 4, 457, pp. 6-9; July 25, 1954. Illus., Map.

Coal Burning Gas Turbine Progress in 1954—Report by J. I. Yellott and Peter R. Broadley. Bituminous Coal Research, April-June 1954, pp. 8-12. Illus., diagrs.

La Convention "EUROP," by M. Bondin. Revue Générale des Chemins de Fer, May 1954, pp. 243-253. Regulate pool of 100,000 freight cars in international traffic. Signed March 2, 1953. Effective March 15, 1953.

Electric Locomotives for South African Railways—Mainline units of 3,030 h.p. for passenger and goods services over heavily graded sections. Railway Gazette, August 13, 1954, pp. 181-184. Illus. and diagrs. "4E" class, built by North British Locomotive Co. Ltd., with electrical equipment by General Electric Co. Ltd.

Der elektrische Zugbetrieb der Deutschen Bundesbahn, by W. Klüsche. Elektrische Bahnen, Munchen, Germany, May 1954, pp. 110-115. Illus. Map.

Die elektrische Zugforderung in Deutschland in Lichte ihrer 75 Jährigen Geschichte, by Alfred Schieb. Die Bundesbahn, May 1954, pp. 360-364. Illus. Bibl. 17 other articles in this issue discuss in detail electrification after the 2nd World War, progress of electric traction, electrification of specified sections of Die Bundesbahn and related subjects, with illus., maps, and bibliography for each article.

Die erste Mast für die elektrische Zugforderung an Rhein und Ruhr gesetzt. Die Bundesbahn, July 1954, pp. 708-713. Illus.

L'établissement du Chemin de Fer dans la Vallée du Rhone entre Lyon, Valence & Avignon (1845-1855), by Vauquesal-Papin. La Vie du Rail—Notre Métier, No. 454, July 4, 1954.

Ganz of Budapest, Hungary, delivers Five-Car, Gear-Drive [Diesel] *Trains for Argentina.* Diesel Railway Traction, July 1954, pp. 165-166. Illus. " . . . 1,200 h.p. provided for long-distance air conditioned broad-gauge sets for the old Buenos Ayres Pacific Railway."

Herbert Melville ("Hub") Hoxie, by Ora Williams. Annals of Iowa, Des Moines, Iowa, July 1954, front. (port of Mr. Hoxie), pp. 321-330; *Kasson and Hoxie Leadership,* p. 330; *Pioneer Became Railway Magnate,* by L. F. Andrews, pp. 331-336. "Managed Underground Railroad" p. 333. " . . . At the close of the [Civil] war, Hoxie joined General Dodge in building the Union Pacific railroad, and they became firm, fast friends. During his connection with that big enterprise, he developed a remarkable ability for railroad construction. When the International and Great Western railroad was started, he was made general manager. Later he was elected first vice-president of the Missouri Pacific during its construction. Then he went south and gridironed Arkansas, Texas, and Missouri with railroads until he controlled more miles of railway than any man in the United States. . . . " (p. 335).

How To Find Information. Royal Bank of Canada Monthly Letter, August 1954. 4 p. Especially if you are working on a report on railroads.

I Still Like Trains, by A. C. Kelmbach. Trains, August 1954, pp. 14-17. Illus. "In 1941 Al Kelmbach penned an essay entitled 'I like Trains.' Recently he was asked if he'd changed his mind since then." He writes:— "Yes, my map is full of ink-marked memories: lines I rode before passenger service was gone— . . . ; and lines which have gone completely and forever . . . lines I can and will visit again . . . To these add the railroad routes I have never traveled, . . . With my map spread out on the living room floor in front of me it looks to me, seriously, as though I have a lifetime program ahead of me—and I'll *still* like trains." (p. 17).

International Railway Congress Number, 1954. Railway Gazette, London, Special Number. 96 p. illus., maps. 5 shillings. " . . . This special number . . . continues the policy inaugurated by an earlier special issue produced on the occasion of the last International Railway Congress in London. In that, a review was made of the growth and development of the railways in Britain from their early years until 1925, the year of that Congress. In this publication, an attempt has been made to present the further progress and change which has taken place during the intervening years to the present time, and, in so doing, to bring the record up to date.

Iron Ore from Labrador—Building 362-mile railroad into remote area heads 200-million dollar development program—Shipments from

fabulous Ungava deposits began the first of August, by J. P. Smallwood. Compressed Air, July 1954, pp. 186-193; August 1954, pp. 223-229. Illus., location map, diagrams. See also in this list: *Quebec, North Shore & Labrador Ry. . . .*

James Proctor Knott's Speech on Duluth, edited by Philip D. Jordan. Minnesota History, Summer 1954, pp. 67-78. "On January 27, 1871, the Honorable James Proctor Knott, Democratic congressman from Kentucky and former attorney general of Missouri, sought recognition from the speaker of the House of Representatives [James G. Blaine]. . . . The humorous address which followed, . . . was not typical of Knott's style or delivery . . . This speech not only gave him a reputation which perhaps he did not deserve, but also killed the grant for the St. Croix and Lake Superior Railroad . . . [Notes of reprints and abstracts printed from 1871-1944] . . . In order to make available an exact transcript, the text that follows has been taken from the first printing as recorded in the *Congressional Globe* for January 27, 1871. . . ." Illustrations show pictures of Duluth in early 1870s.

Locomotive 2300—N. & W.'s Experimental Steam Turbine-Electric Engine Is Undergoing Road Tests. Norfolk & Western Magazine, June 1954, pp. 338-340, 398. Illus. include front cover picture in color.

A look at railroad maps today leads this writer to believe THERE'S ROOM FOR IMPROVEMENT, by Richard L. Neuberger. Railway Progress, July 1954, pp. 10-16. Illustrated by cartoons that emphasize suggested improvements.

New Orleans' New Union Passenger Terminal:—*Dedicate New $16 Million Terminal—New Union Passenger Terminal is key to $57 million citywide public improvement program that is making a "new" City of New Orleans.* Modern Railroads, June 1954, pp. 53-84. Map and illus., incl. front cover in color. *Union Passenger Terminal—you no longer need climb aboard a bus for a Hair-breadth Harry ride way across town to change trains in New Orleans.* Trains, September 1954, pp. 14-19. Photos by James G. La Vake. "These trains serve New Orleans" box, p. 16.

Nuove prospettive del campo dei trasporti urbani. Conferenza . . . il 4 marzo 1954. Reported by Prof. Ing. Vittorio Immirzi. Ignegneria Ferroviaria, Rome, Italy, May 1954, pp. 376-382. Illustrated with plans, maps and diagrams of "moving roads" in subways proposed for New York City by Col. Sidney Bingham, and for Rome by several Italian engineers. Brief summary in English on yellowpage facing Table of Contents.

Passenger Conveyors Spark Wide-Spread Interest. Modern Materials Handling, July 1954, pp. 31-32.

Private Varnish, by Lucius Beebe. Town & Country, August 1954, pp. 74-75, 99-102. Illustrated with pictures of private cars of "moguls and caliphs of commerce" and others.

Quebec, North Shore and Labrador Railway—Reconnaisance . . . 1945, Seven Island to Lat. N. 54°44' Long. 66°42' W, by D. A. Livingston. The Engineering Journal, Engineering Institute of Canada, April

1954, 399-405. Illus. Map of the route, pp. 400-401. *The Location and Construction* . . . by B. M. Monaghan, assistant chief engineer. Engineering Journal, July 1943, pp. 820-828. Illus. " . . . Construction started in the fall of 1950 and was completed in December 1953 . . ." (p. 820) Discussion by W. M. Treadgold, pp. 828, 830, mentions: " . . . Railroad construction is very necessary in opening up undeveloped sections of this country and making the natural resources available. This is shown by such presently contemplated construction as the I.C.O. Railway—360 miles, Chibougamau—300 miles, Lynn Lake—160 miles, Kitimat Development—100 miles. These roads are all being constructed on the basis of high grade construction and operation. Canadian railways are now offering courses covering construction and maintenance as they are extremely anxious to get technical men. Evidently these men are not available and it seems too bad that courses in railroad engineering are being neglected by the various universities and that the possibilities of the many phases of railroad construction and operation are not emphasized in the courses open to the student. . . . "

"Rail et Humour"—Numero Special [May 1954] presenté par Emile Henriot de l'Academie fran, caise . . . La Vie du Rail—Notre Métier 1954. 40 p. Illustrations and Cartoons. 40 francs.

Railroads Go to the Grass Roots—Eastern railroads now have a positive, organized approach rather than one dependent upon individual enthusiasm. Community relations program of Eastern Railroad Presidents Conference, presented by J. Carroll Bateman at annual meeting of Railroad Public Relations Association. Modern Railroads, August 1954, pp. 99-104. Illus., Map, Charts.

Railroads in Canada. The Royal Bank of Canada, Montreal, Monthly Letter, April 1954, 4 p. " . . . Canada uses more railway transportation per person than any other country in the world, and Canada's unit cost of transportation is the lowest of all the hard currency countries."

The Regulatory Process, by Howard Freas, member, Interstate Commerce Commission. Speech, May 19, 1954, at annual group meeting luncheon, Association of Interstate Commerce Commission Practitioners, Boston, Mass. I.C.C. Practitioners' Journal, June 1954, (Section I), pp. 809-818 Abstract in Railway Age, June 7, 1954, pp. 8-9, Editorial comment: *De-Regulate the Regulated or Extend Regulation?* Railway Age, August 23, 1954, p. 29.

Railroad Research—Better Service, Lower Costs, by Donald C. Spaulding. Nation's Business, August 1954, pp. 38-39.

Railway Pipeline from Kilimanjaro, E. A. R. & H. [East African Railways & Harbours]—*Gravity water supply being provided for locomotives on Mombasa-Nairobi line.* Railway Gazette, July 23, 1954, p. 100. Illus. " . . . It has been possible, in the past to obtain sufficient water from shallow springs and boreholes . . . When complete, the pipeline will be 65 miles long . . . and the quantity of water . . . is expected to be about 500,000 gal. a day. . . . the railway administration will not

alone benefit from this scheme, as it has agreed to a proposition of the water being tapped for the use of the Masai herdsmen at five points along the line."

Resultados obtenidos con los trenes automotores de la RENFE, by Federico Escario y Nunez del Pino. Ferrocarriles y Tranvias, Madrid, Spain, May 1954, pp. 164-172. Illus., Graph, Map. " . . . los trenes Taf" constructed by Fiat, Turin, Italy.

Riding the Rails with the Fast Freight, by Evan McLeod Wylie. American Magazine, July 1954, pp. 20-21, 82-86. Map of route of "2,000-mile adventure with a big red boxcar named *Lucy.*" Illus. Reprinted by Association of American Railroads, Transportation Bldg., Washington 6, D. C. cover-title, [6] p. Free on request to A.A.R.

Sand Mountains and Sawgrass Marshes, by Jean E. Keith. Alabama Review, April 1954, pp. 99-112. " . . . Upon the economic growth and development of the Central South in the last quarter of the Nineteenth Century, the railroad builders exerted a tremendous force. . . . "

75 Jahre elektrische Lokomotiven, by F. Schlemmer. Elektrische Bahnen, Munchen, Germany. May 1954, pp. 101-110. Illus., diagrs.

Southern Province Railway and Port, Tanganyika—A 133-mile line serving the new deep-water port of Mtwara on the Indian Ocean. Railway Gazette, London, England, August 6, 1954, pp. 152-154. Map and illus. "Mtwara . . . had its origin in the Overseas Food Corporation's Groundnut Scheme. Construction was begun in 1948. At the opening ceremony on July 17 [1954], . . . "

Steam: Where To Find It In 1954.—An exclusive TRAINS report on what railroads are operating steam power where this summer. Trains, August 1954, pp. 19-21.

TALGO—June to September: *The Future of Talgo,* by Col. S. H. Bingham. Modern Railroads, June 1954, pp. 89, 91. Reprint. New York, 1954. 12 p., illus.; *Rock Island may beat Young to the rails with a radical train. New Haven line also discloses it plans test of Talgo train, ACF product, used in Spain,* by Nancy Ford. Wall Street Journal, June 18, 1954, pp. 1, 6; *Futuristic Train Finds A Buyer.* Business Week, June 26, 1954, p. 76. " . . . *Last Week, the Rock Island RR. . . . "; Rock Island Buys . . . first new-type* Talgo . . . Railway Age, June 28, 1954, pp. 60-61. Illus. "To get more detailed information for Railway Age, a team of reporters interviewed President John D. Farrington. . . . "; *Talgo sets New Haven speed record . . . test run* [June 29] . . . Modern Railroads, August 1954, p. 53; *Now, Talgos on U. S. Railroads* [Jet Rocket to be first Talgo-style train on U. S. lines] Diesel Power, August 1954, pp. 38-41. Illus., diagrs.; *Study of Spain's "Talgo" Train was the object of a recent trip to Madrid by a group of American railway mechanical engineers. Shown here are . . .* [photograph]. Railway Age, August 23, 1954, p. 7; *Here Comes Pat McGinnis—An evaluation of New Haven's new boss, . . .* by David P. Morgan. Trains, September 1954, p. 50. " . . . He's not kidding about buying low-slung articulated Talgo-type equipment . . . It's the answer, he feels, to the impending airline encroachment of the short-haul routes served by New Haven. . . . Illus.

They've Been Working on the Railroads, by W. A. Powers. Town & Country, August 1954, pp. 70-73, 88, 90. Illus. part in color. " . . . Until private automobiles and busses began to offer competition, the railroads held an absolute monopoly on travel and saw no need to spend extra sums on the coddling of ordinary passengers who in most cases had no other choice but to put up with existing discomforts or else stay at home. New coach equipment was virtually unknown. . . . The lightweight streamliners changed this picture almost overnight. . . . "

Through Wagon Traffic from Spain. Railway Gazette, August 6, 1954, p. 145. Editorial summary of article in Ferrocarriles y Tranvias, by L. Saldana Muzquiz of Spanish National Railways, describing growth of fruit traffic in carloads from Spain and Portugal to Britain, France and Germany. " . . . This traffic is carried exclusively in refrigerated stock in complete trains taking 98 hr. from the main collecting point in Spain to London . . . Return loading presents difficulties, some connected with Customs regulations. A temporary relaxation was obtained, however, and in 1953, 335 return through wagons carried freight into Spain, mostly road motor vehicles, and it is hoped to develop the service further."

. . . *Traction Diesel—Special Technique.* La Vie du Rail—Notre Métier, [Special Number] 1954. 72 p. Illus., diagrams. Preface by Louis Armand, directeur général, SNCF. *La Traction Diesel* en France, p. 26; en Afrique du Nord et de la France d'Outre-Mer, pp. 34-35; en les chemins de fer departmenteaux et secondaires, p. 41; en Allemagne, p. 44; en Suisse, en Belgique et aux Luxembourg, p. 47; en Autriche et en Hongrie, p. 49; dans les pays scandinaves et en Finlande, p. 50; en Grande-Bretagne, p. 52; en Australie, p. 54; en U.S.S.R., p. 56; aux Etats-Unis, p. 58; au Canada et en Amérique Latine, p. 63; dans le reste du monde, p. 68.

Trailers-on-Flat-Cars — "Piggybacks" — Memorandum, July 19, 1954, listing material published from February to July 15, 1954, by Elizabeth O. Cullen, librarian, Bureau of Railway Economics Library, Association of American Railroads, Washington 6, D. C. cover-title, 26 proc. 1. Free on request to BRE Library. Supplements memorandum on history of service with same title, revised to February 2, 1954. I.C.C. decision in *Docket No. 31375—Movement of Highway Trailer by Rail* was decided July 30, 1954. 29, 2 proc. p. Available on request to I.C.C. Printed copies with volume number assigned, will be available later.

Train Rides for the Kids. Modern Railroads, July 1954, pp. 75, 77. Illus. L & N's Kiddie Special, Louisville to Lebanon Junction, Ky. and back, and Burlington's weekend trips from towns in Illinois and Iowa to Chicago, and other cities.

Les Trains Sur Pneumatiques du Chemins de Fer métropolitain de Paris, by M. Ruhlmann. Révue Generale des Chemins de Fer, April 1954, pp. 173-193. Illus. and diagrs. Summary in English "Use of pneumatic-typed trains by the Paris Underground Railway." p. 228.

The Trend to Trains. Town & Country, August 1954, pp. 76-81. Illus.

Want To Borrow A Diesel?—Hard pressed by a shortage of locomotives and cars during heavy traffic periods, the BAR has launched an equipment exchange program with other railroads, by Bruce Nett. Railway Progress, August 1954, pp. 37-41. Illus. " . . . the Bangor and Aroostook . . . This live wire Yankee railroad has always had a seasonal equipment problem on its hands. . . . "

Westinghouse Gas-Turbine Locomotive. Diesel Railway Traction, June 1954, pp. 142-145. Illus. Diagr.

World's First Moving Sidewalk. Business Week, May 29, 1954, p. 33. Illus.

New Books

Arid Domain—The Santa Fe Railway and its Western Land Grant, by William S. Greever. 184 pages, 9¼x6. Published by Stanford University Press, Stanford, California. Price $4.00.

One of the early railroads in the west was the Atlantic & Pacific which was to extend from St. Louis to the Pacific. That it was unable to build through Indian Territory was perhaps as much the fault of the politicos in Washington as anyone. At the time of its receivership and subsequent reorganization into the St. Louis & San Francisco R. R. the lands granted the Atlantic & Pacific in the states of Arizona and New Mexico were used to extinguish their indebtedness and the Santa Fe Pacific, a subsidiary of the Atchison, Topeka & Santa Fe Ry., came into their possession.

Unlike many of the lands granted our western railroads, these could not be used for farming and this called for different management. Lands were leased and sold for grazing purposes and the management was always careful to protect the lessor by giving him the first option in case of sale. The same applied to the timber lands. One of the first acts of the railroad was to consolidate its lands by means of exchanging the odd numbered sections within Indian reservations for lieu rights outside the land grant area.

The ranchers disliked the sheep raisers, the timber operators were careless in their operations, there was skepticism on the part of Government officials and members in congress but withal, thanks to the capable management of Howell Jones, manager of the land grants for 27 years, the author pays this final tribute in that the grant was managed "with strict honesty, showing due consideration for the welfare of the public in general" and that a real contribution was made to the economic development of New Mexico and Arizona.

Of recent years these grants of land made to our western railroads have been much in the public eye and much mis-information has been published on the subject, by some of our newspapers and magazines. This author appears to have approached this subject with an open mind and to some of us whose interests extend beyond the operational functions of a railroad, this book should open a new vista in the handling of some ten million acres of land in the south-west.

The author has included six maps in this volume which aid greatly in placing the events and he has told his story in a straight-forward manner that adds greatly to the enjoyment of this history. As a member of this group he deserves our congratulations for a difficult task that was very well done.

The Crookedest Railroad in the World, by Theodore G. Wurm and Alvin C. Graves. 121 pages, 8⅜x5⅜, illustrated. Published by Academy Library Guild, Fresno, California. Price $3.75.

Mt. Tamalpais, rising 2500 feet north, across the bay from San Francisco, in Marin County, has been held in the affections of the people

of that locality. From 1896 to 1930, the sides of the mountain echoed to the sharp exhausts of the Lima Shay-geared locomotives as they pushed their loads of passengers up the 8½ mile railroad to the summit. The ferry trip to Sausalito, the short ride to Mill Valley on the Northwestern Pacific R. R., were brought to a fitting climax by the spread of marvelous panorama of the entire bay and cities as one made the ascent. Further thrills came at the "double Bow Knot," the water stops for the thirsty locomotive and the final entrance to the "Tavern of Tamalpais."

Whether you were a visiting dignitary or a plain tourist, the ride on this little road was a "must" and it was a favorite recreation spot for the San Franciscan on a Sunday or week end. The management capitalized on any and every event to run an excursion to the summit.

The gravity cars, the invention and design of "Bill" Thomas, Master Mechanic of the road, were an outstanding feature. What trip would equal this 8½ mile descent, with slow downs at the proper points to view the breath-taking scenery on a bright moon-lit night! In the right company, say with a group of rail-fans on the Pacific Coast, it could have no equal anywhere.

Well, the little road, like many of the others, had to succumb to the automobile which came up the toll road that was built on the north side of the mountain to the summit. The summer of 1930 saw final abandonment.

The authors, guided by Roy D. Graves, have shown a genuine love and affection for this little railroad. They have told their story simply but well and this, together with the countless illustrations that add so much to the story make this a well worth-while volume to own.

History of American Industrial Science, by Courtney Robert Hall. 453 pages, 8½x5½. Published by Library Publishers, 8 West 40th Street, New York (18), N. Y. Price $4.95.

This book is in recognition of the inter-relationship of scientific research and industrial management. A certain amount of space has been given to the historic development of industry and new and industrial material has been furnished by sixty of our leading corporations. The author interprets a variety of facts on American industry on such vital matters of our national defense and the possibilities of future social and political developments in the western world. Its contents ranges from agriculture to atomic energy and from dairy products to detergents. The subject of transportation, all forms, has not been overlooked and over fifty pages are devoted to this subject. Commencing with our colonial industry, through the age of steel, we are brought to the present with its myriad industries and development. In addition to serving the business man and the student, the book should interest the general reader who is interested in what makes the "wheels go around" in these United States.

Pioneer Railroads, by Hank Wieand Bowman. 144 pages, 9¾x6⅝, illustrated. Published by Arco Publishing Co., 480 Lexington Ave., New York (17), New York. Price $2.00.

In this book the author attempts to trace the development of the steam locomotive from the ancient Aeolipile to Civil War Days and the development of our railroads to the union of the Central Pacific and Union Pacific Railroads on May 10th, 1869. There is a wealth of material on our first railroads—Baltimore & Ohio, the South Carolina, the roads owned by the Commonwealth of Pennsylvania and others.

To this reviewer the book shows a lack of knowledge on the part of the author of some of our early railroad history and mechanical features of a locomotive. On page 10 he places the Granite Ry. in Charlestown, Mass., but in the next paragraph he places it properly from the Quincy quarry to the Neponset River; on page 21 he makes the same mistake that others have made relative to the names of the first four locomotives of the Delaware & Hudson and on page 25 he writes of the Negro fireman shutting the exhaust valve that caused the explosion of the "Best Friend." It was the safety valve the fireman tied down and no valves are put in this steam line for very obvious reasons. And there are others.

The book is richly illustrated but, here again, the captions and titles to some dozen or more are either inaccurate or else worded in such a way as to give the reader a wrong impression.

It seems unfortunate that what could have been an excellent piece of work contains many serious errors simply through the source material used by the author and his seeming inability to cope with the actual facts. That there is a need for a book of this type and size no one will deny but it is too bad that the author did not see fit to consult better source material.

In Memory of

Mrs. Mary G. Cumming
Annual Member
2231 Cumming Road, Augusta, Georgia
Who died on June 20, 1954

Robert H. McFarland
Annual Member
133 Foerster St., San Francisco, California
Who died on June 27, 1954

Frank B. Ramsdell
Life Member
Putnam, Connecticut
Who died on August 3, 1954